International Conference for Celebration of 60th Anniversary of
UNESCO Kalinga Prize for Popularization of Science
Bhubaneswar, Odisha, India



Jointly Organized by

Kalinga Foundation Trust
Bhubaneswar, Odisha

United Nations Educational, Scientific & Cultural Organization (UNESCO)
Paris, France

Department of Science & Technology
Government of Odisha
Bhubaneswar

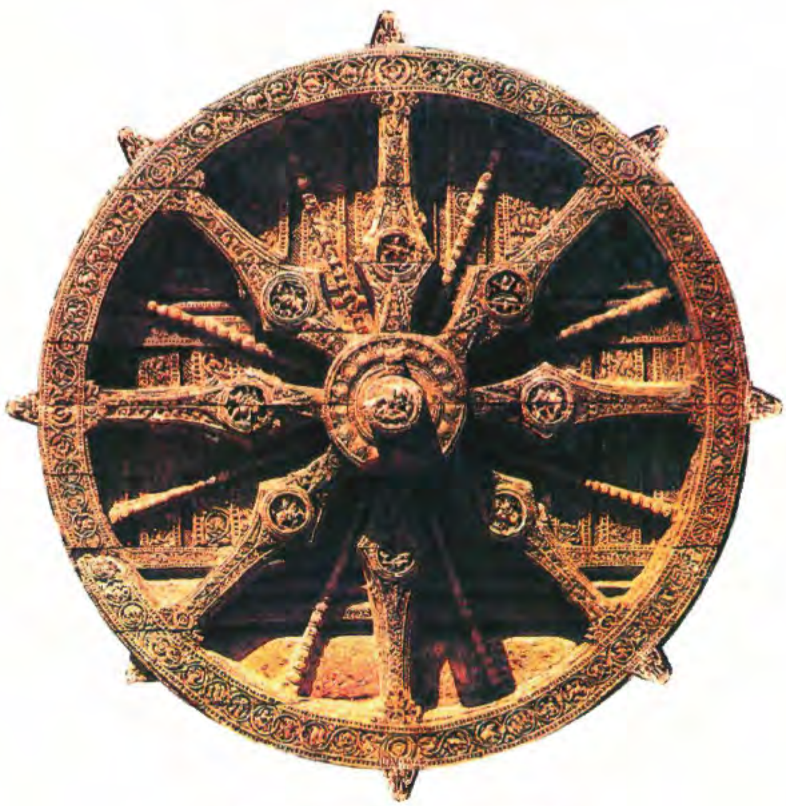
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Dated: 4th & 5th January, 2012


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International Conference for Celebration of 60th Anniversary of
UNESCO Kalinga Prize for Popularization of Science
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&
Ministry of Human Resource Development
Government of India
New Delhi

Venue :
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अर्चना दत्ता (मुखोपाध्याय)
राष्ट्रपति के विशेष कार्याधिकारी (जन सम्पर्क)
Archana Datta
(Mukhopadhyay)
OSD (PR) to the President

राष्ट्रपति सचिवालय,
राष्ट्रपति भवन,
नई दिल्ली -110004
President's Secretariat,
Rashtrapati Bhavan,
New Delhi - 110004



MESSAGE

The President of India, Smt. Pratibha Devisingh Patil, is happy to know that the Kalinga Foundation Trust, Bhubaneswar, UNESCO, Department of Science and Technology, Government of Odisha, DST, Ministry of Science and Technology, Government of India and the Ministry of HRD, Government of India are jointly organising an International Conference for Celebration of the 60th Anniversary of UNESCO Kalinga Prize for Popularization of Science on January 4-5, 2012 at Bhubaneswar.

The President extends her warm greetings and felicitations to the organisers and the participants and wishes the Conference all success.

A. Datta

Officer on Special Duty (PR)

Tel. : 011-23016535(Direct), 23015321 Extn 4322, Fax 23794498, E-mail-osdad@rb.nic.in



Murlidhar C. Bhandare

GOVERNOR, ODISHA

December 31, 2011

MESSAGE

I am glad to know that Kalinga Foundation Trust, Bhubaneswar; UNESCO; Department of Science & Technology (DST), Government of India; Ministry of Human Resource Development, Government of India and Department of Science & Technology, Government of Odisha are jointly organizing an International Conference for celebration of 60th Anniversary of UNESCO Kalinga Prize for popularization of Science on January 4-5, 2012 alongside the 99th Indian Science Congress at Bhubaneswar. Besides a Commemorative Souvenir, a book entitled "UNESCO Kalinga Laureates for Universal Peace" containing life and works of all 66 UNESCO Kalinga Laureates is also being brought out commemorating the occasion.

Kalinga Prize instituted by the legendary statesman and former Chief Minister of Odisha late Shri Biju Patnaik through UNESCO in the year 1951 is indeed a great step towards promotion of scientific activities and technology for the benefit of people. The Prize signifies his commitment and far sighted vision for popularization of science. During 60 years many brilliant scientists across the world including several Nobel Laureates have been honoured with this coveted prize for their outstanding work. I am sure the assemblage of eminent scientists and their deliberations at the Conference will lead to significant breakthrough in the endeavours towards popularization and public understanding of science. The publications will also be highly enlightening.

I wish the occasion and publication all success.

(Murlidhar C. Bhandare)

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D. O. No. ....893..........

BHUBANESWAR

Dated ...30.12.2011........

MESSAGE

I am happy to learn that Kalinga Foundation Trust, Bhubaneswar ; UNESCO, Paris ; Department of Science & Technology, Government of India ; Ministry of Human Resources Development, Government of India and Science & Technology Department, Government of Odisha are jointly organizing an International Conference for celebration of the 60th Anniversary of UNESCO Kalinga prize for popularization of science at Bhubaneswar on 4th and 5th January, 2012 which is being concurrently held with the 99th Indian Science Congress. It is further a matter of great pride for Odisha that UNESCO Kalinga prize for the year 2011 will also be presented during the occasion in presence of most of the living UNESCO Kalinga laureates.

I am also glad that a Souvenir is being brought out on the occasion to mark the event containing large number of articles on popularization of science which is most essential for public understanding of science. On this occasion, I pay my tributes to Biju Patnaik, the legendary leader of Odisha, who instituted this award. His contribution to the field of science & technology and its popularization will be long cherished.

I wish the International Conference and the celebration of the 60th Anniversary of UNESCO Kalinga prize all success.

(NAVEEN PATNAIK)



Message from Ms Irina Bokova,
Director-General of UNESCO
on the occasion of the celebration of 60th anniversary of the UNESCO-Kalinga Prize for the Popularization of Science

4 January 2012

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Educational, Scientific and
Cultural Organization

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In a world changing quickly and placing new pressures on our societies, popularizing science has never been so vital. Science holds key solutions to the challenges we must overcome to build more equitable and sustainable development. To unlock these, we must reach out to the widest possible audience, inside countries and across the world. Popularizing science lies at the heart of UNESCO's mandate. It is essential for harnessing the power of science for the benefit of all. In 1951, the same objectives guided the decision by Shri Biju Patnaik, the founder and President of the Kalinga Foundation Trust, to establish the Kalinga Prize for the Popularization of Science with UNESCO

Science impacts on all aspects of human development. All of us should have the skills to understand the challenges that affect their lives and their world - from poverty to the impact of climate change. We must democratize scientific knowledge to widen understanding and to build stronger constituencies for action. This is especially important for the most vulnerable members of our societies.

This calls for a deeper dialogue between the scientific community and the whole of society. It requires more inclusive decision-making and choices to translate science into technologies for the benefit of all. Every member of society should know more about the scope of scientific knowledge today and the opportunities it opens for sustainable development in the future.

Popularising science starts with museums, shows, and fairs. It includes all activities that communicate scientific knowledge and scientific methods to the public, outside the formal setting of classrooms. It also encompasses work to promote public understanding of the history of science, in order to deepen awareness of the contributions of all cultures and to recognize the importance of cultural diversity.

These are the goals of the UNESCO-Kalinga Prize for the Popularization of Science. This Prize rewards the efforts of a person with a distinguished career as a writer, editor, lecturer, radio/television programme director or film producer, helping the public to interpret science, research and technology for the improvement of public welfare, the enrichment of the cultural heritage of nations and for finding solutions to the problems facing humanity. Sixty five individuals from twenty four countries have received the award to date, six of whom have been Nobel Prize laureates. Until 1993, the majority of winners were from developed countries. The focus has shifted since then to developing countries. This welcome trend reflects increasing support across the world to the generation of scientific knowledge.

On this 60th anniversary of the UNESCO-Kalinga Prize for the Popularization of Science, I wish to thank all Prize winners, the Kalinga Foundation Trust and all of our partners for their engagement with this cause. I look forward to our continued cooperation to share the wonders of science for the benefit of all. I am convinced this is an important step towards building a more peaceful, equitable and sustainable world.

Irina Bokova

Irina Bokova

KALINGA FOUNDATION TRUST

REGISTERED UNDER THE SOCIETIES REGISTRATION ACT 1860
Kalinga Bhawan, A/62/1, Nayapalli, Bhubaneswar-751 012
Tel.: (0674) 2394454



MESSAGE

It is a matter of great pride and prestige for Odisha that an International Conference for Celebration of 60^{th} Anniversary of UNESCO Kalinga Prize for Popularization of Science is being held at Bhubaneswar under the aegis of Kalinga Foundation Trust, Bhubaneswar; UNESCO, Paris; Department of Science & Technology (DST), Govt. of India; Ministry of Human Resource Development (MHRD), Govt. of India and Science & Technology Department, Govt. of Odisha during 4^{th} – 5^{th} January, 2012. Addl. Director General of UNESCO, Paris and team of officials from UNESCO are also gracing the occasion which will make the event more memorable.

On this memorable moment, I fondly remember the unforgettable memories of Late Biju Patnaik, Founder of Kalinga Foundation Trust, who way back in the year 1951 instituted the Kalinga Prize through UNESCO, Paris and since 1952 , 65 Eminent Scientists and Science Popularizers from 23 countries have been bestowed with this highest honour of the world on Popularization of Science. Further, it may be noted that the Kalinga Prize for Popularization of Science is the only international prize of our country. Sri Hare Krushna Mehtab, Sri Naba Krushna Choudhury, Sri Biren Mitra, Sri Nilamani Routray, all former Chief Ministers of Odisha, were the Chairmen of Kalinga Foundation Trust. Late Smt. Gyan Patnaik, wife of late Biju Patnaik, was also an active member of the Kalinga Foundation Trust. Late Justice Sadhu Charan Mohanty, Late Chandra Mohan Singh, former Managing Trustee of Kalinga Foundation Trust, and Late Raja Saheb of Sonepur of Bolangir District of Odisha were also members of the Kalinga Foundation Trust. During their tenure, they have contributed immensely for the all-round growth of Kalinga Foundation Trust.

On this auspicious occasion, I also remember the close association of Late Kamini Kanta Patnaik, former Managing Trustee of Kalinga Foundation Trust had with the legendary Biju Patnaik for institution of the Kalinga Prize for Popularization of Science among the masses. Due to his endless passion & untiring efforts & consistent coordination with the DST, Govt. of India

& Govt. of Odisha, led to increase in the prize money from 1000 Pound to 20,000 US Dollar. Though by training, he was a lawyer, he had a strong belief that Popularization of Science is the only tool which can lead to development of mankind. Kalinga Foundation Trust also got its office and establishment during his tenure. Further, during his tenure, Highest State Level Award "Kalinga Samman' for Popularization of Science was also instituted for the first time in the year 2010 to acknowledge the Outstanding Contributions of Eminent Odia Scientists and Science Popularizers, living anywhere in the world, in the field of Popularization of Science. The Award carries a Cash Prize of Rs. 1 lakh , a Citation and a Memento. But it is a matter of great sorrow for all of us that he could not be present amidst us to see this memorable occasion & he left for his heavenly abode only a few months back. Little latter , I joined with the team of Biju Babu and Kamini Kanta Patnaik for the noble cause of Popularization of Science and since last 60 years or so, I am closely associated with the activities of Kalinga Foundation Trust.

I am excited with joy and contentment that 13 living UNESCO Kalinga Laureates from different countries of the world are coming to Bhubaneswar to grace the occasion. They will also be felicitated by the Hon'ble Chief Minister of Odisha Sri Naveen Patnaik during the Inaugural Session. Their scientific expertise and valuable advice will be taken for all-round growth of Kalinga Foundation Trust. They will be one among us. Moreover, current all Jury Members of UNESCO Kalinga Prize designated by Director General, UNESCO, Paris are also stepping in to the City of Temples, Bhubaneswar to witness this mega global event on Popularization of Science. More than 150 Delegates from India and abroad are participating in the International Conference. Further, UNESCO Kalinga Prize for the year-2011 has been recently announced to be presented to Dr. Rene Raul Drucker Colin of Mexico. A Book entitled "UNESCO Kalinga Laureates for Universal Peace" depicting the life & work of all the 66 UNESCO Kalinga Laureates will also be released on the occasion. A Souvenir containing Articles on Popularization of Science contributed by noted Scientists and Authors from the country and abroad will also be released during the event.

I convey my best wishes for the success of the International Conference being organized to Celebrate 60th Anniversary of UNESCO Kalinga Prize for Popularization of Science and hope for the establishment of Universal Peace & Brotherhood throughout the world by Popularization of Science which is the aim of Kalinga Foundation Trust.

Jaihind.

Bhabani Charan Pattanayak

(Bhabani Charan Pattanayak)
Chairman
23-12-11

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डॉ.टी.रामसामी
सचिव
Dr. T. RAMASAMI
SECRETARY

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MINISTRY OF SCIENCE & TECHNOLOGY
DEPARTMENT OF SCIENCE & TECHNOLOGY
Technology Bhavan, New Mehrauli Road, New Delhi-110 016



MESSAGE

UNESCO-Kalinga Award for Popularization of Science has emerged as a recognition to important contributions making global impact. The Award has gained its value and esteem through the fame of the past awardees. Commemoration of the 60th Anniversary of the principle behind the institution of the award is both valuable and commendable.

Global perception of the role of science in socio-economic development has undergone significant changes. In modern world, public perception of science has enhanced. Science today includes also technology and innovation and no longer remains an 'Irony Toner' activity. Public understanding of science has become necessary.

UNESCO-Kalinga Award fulfills an important need namely global recognition of those who serve the society through popularization of science. My warmest greetings to the Kalinga Foundation and UNESCO on the 60th Anniversary of institution of the Prize.

I convey our thanks to all UNESCO-Kalinga Laureates for their outstanding work aimed at popularization of science and promotion of universal peace.

(T. Ramasami)

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राष्ट्रीय विज्ञान शिक्षा एवं अनुसंधान संस्थान, भुवनेश्वर
(परमाणु उर्जा विभाग, भारत सरकार का एक स्वयं शासित संस्थान)
NATIONAL INSTITUTE OF SCIENCE EDUCATION AND RESEARCH, BHUBANESWAR
(AN AUTONOMOUS INSTITUTE UNDER DEPT. OF ATOMIC ENERGY, GOVT. OF INDIA)

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निदेशक
PROF. T. K. CHANDRASHEKAR, FASc, FNA, FTWAS
Director



MESSAGE

I am happy to note that the International Conference for Celebration of 60th Anniversary of UNESCO Kalinga Prize for Popularisation of Science is being organized along with the 99th Indian Science Congress from 4-5th January 2012 in KIIT University. This is an important event to popularize science and technology among the people and students of the country and the state of Orissa in particular. It provides a forum for scientists, academicians and students of the state for exchange of ideas and create an environment for collaborative endeavors in the emerging interdisciplinary areas. I hope this landmark event will be successful in creating a scientific fervor among aspiring young students & scientists to take up challenging research and teaching assignments in universities, R&D laboratories and various industries within the country and abroad. I wish this conference all success.

T.K Chandrashekar

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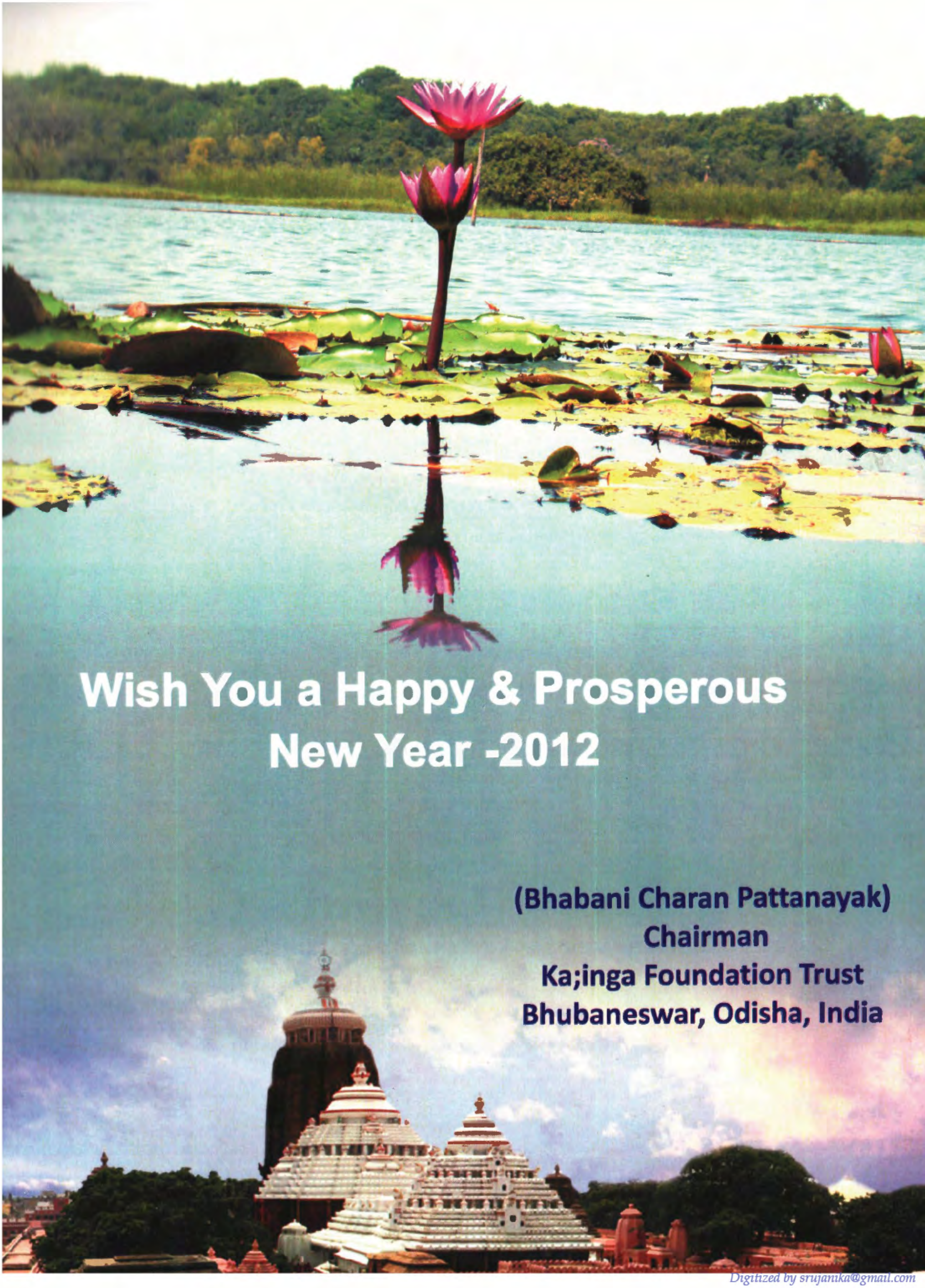


I am happy to know that an International Conference for Celebration of 60th Anniversary of UNESCO Kalinga Prize for Popularization of Science is being held at Bhubaneswar from 4th to 5th January, 2012. On the occasion, a Souvenir is being published containing large number of articles on popularization of science contributed by eminent scientists and science popularizers of the country and abroad.

Science is the most important tool through which societal change can be accomplished. Through Popularization of Science among the masses, scientific spirit can reach the people at the grass root level which was the dream of Biju Babu.

I convey my best wishes for the celebration.

Sri Pyari Mohan Mohapatra
Hon'ble Member of Parliament(Rajya Sabha),
&
Chairman,Reception Committee,
60th Anniversary of UNESCO Kalinga Prize


Wish You a Happy & Prosperous
New Year -2012
(Bhabani Charan Pattanayak)
Chairman
Ka;inga Foundation Trust
Bhubaneswar, Odisha, India



EDITORIAL

It is a matter of great pleasure for me to be associated with the International Conference for Celebration of 60th Anniversary of UNESCO Kalinga Prize for Popularization of Science being held at Bhubaneswar from 4th to 5th January, 2012 & jointly organized by UNESCO, Paris; Kalinga Foundation Trust, Bhubaneswar; DST, Govt. of India; Ministry of HRD, Govt. of India and Science & Technology Department, Govt. of Odisha. Further, I am happy to know that most of the living UNESCO Kalinga Laureates and all the Jury Members of UNESCO Kalinga Prize are also gracing the occasion. Mrs. G.Kalonji, Assistant Director General of UNESCO, Paris is also visiting Bhubaneswar for the purpose. The event will be a memorable one in the world history of Popularization of Science which will enkindle the passion for Science in the minds of the masses for time immemorial.

I had a long history of association with the Kalinga Foundation Trust, Bhubaneswar and UNESCO, Paris as a Member of the Jury for a period of 6 years for the award of Kalinga Prize. I am also acting as a Jury Member for the "Kalinga Samman" for Popularization of Science, the highest State Level Award instituted by Kalinga Foundation Trust, Bhubaneswar for the first time from the year 2010 to recognize Outstanding Contribution of Odia Scientists and Science Popularizers working anywhere in the world in the field of Popularization of Science. Reception Committee requested me to take up the responsibility of Editor-in-Chief of the Souvenir which will be released on the occasion. I gladly accepted the assignment. The Souvenir contains 37 articles on various issues on Popularization of Science. The articles have been contributed by eminent scientists and science popularizers from various countries. I thank all the contributors and the Editorial Team for providing necessary support in bringing out the publication.

(Trilochan Pradhan)

Mr. Davidson Hepburn, President,UNESCO, Paris

visits Bhubaneswar, Odisha, India, on 12th November, 2010
On the Occasion of Celebration of
59 Years of UNESCO-India Day & 58 Years of Institution of UNESCO Kalinga Prize



Long Live, Long Live
Indo- Unesco Treaty Long Live



Long Live, Long Live
UNESCO Kalinga Prize Long Live

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  Board, Bhubaneswarr
- **Sri Madhu Mohanty**
  Managing Director, Dainik Bhaskar
  (Odia Daily News Paper),
  Bhubaneswar **Convener**

Souvenir:

- **Dr. Basudev Kar**
  President, Orissa Science Academy,
  Bhubaneswar **Chairman**
- **Dr. (Mrs.) Shashi Ahuja**
  Director, DST,Govt.of India &
  Jury Member, UNESCO Kalinga Prize
- **Dr. Ing. H.P. Mishra**
  Member, Kalinga Institue of Technology &
  Design, Bhubaneswar
- **Padmashri Dr. P. K. Jena**
  Member,Kalinga Institue of Technology &
  Design, Bhubaneswar
- **Padmabhusan Prof. Trilochan Pradhan**,
  Ex- Vice- Chancellor, Utkal University ;
  Ex- Director, Institute of Physics, Bhubaneswar
  & Ex- Jury Member of Kalinga Prize
- **Dr. S.N.Torasia**
  Member,Kalinga Institue of Technology &
  Design, Bhubaneswar
- **Dr. Pramod Kumar Mohapatra**,
  Executive Editor, The Samaj, Cuttack
- **Sri Madhu Mohanty**,
  Managing Director, Dainik Bhaskar (Odia Daily
  News Paper), Bhubaneswar
- **Dr. Chitta Ranjan Mishra**
  Member, Kalinga Foundation Trust,
  Bhubaneswar **Convener**

Registration, Reception. Accommodation & Transport:

- **Dr. A. Samanta**,
  Founder of KIIT & KISS, Bhubaneswar **Chairman**
- **Sri S.P. Patnaik**
  Member,Kalinga Foundation Trust,
  Bhubaneswar
- **Sri Umakanta Mishra**
  Trustee,KalingaFoundation Trust,
  Bhubaneswar
- **Sri Lala Manoj Kumar Ray**
  Member, Kalinga Foundation Trust,
  Bhubaneswar

- **Dr. R.N. Ray**
  Chairman, NCSTC Network, New Delhi
- **Sri Dharmendu Patnaik**
  Trustee, Kalinga Foundation Trust,
  Bhubaneswar **Convener**

Meeting & Decoration

- **Dr. A Samant**
  Founder of KIIT & KISS, Bhubaneswar **Chairman**
- **Sri Madhu Mohanty**
  Managing Director, Dainik Bhaskar
  (Odia Daily News Paper), Bhubaneswar
- **Dr. (Mrs.) Shashi Ahuja**
  Director, DST,Govt.of India &
  Jury Member, UNESCO Kalinga Prize
- **Secretary, Science & Technology Department**
  Govt of Orissa or his Representative
- **Dr. Chitta Ranjan Mishra**
  Member, Kalinga Foundation Trust,
  Bhubaneswar **Convener**

Volunteer

- **Sri Yagneswar**
  President,Odisha State Co-operative
  Bank, Bhubaneswar **Chairman**
- **Sri S.P. Patnaik**
  Member,Kalinga Foundation Trust,
  Bhubaneswar
- **Prof. Tarini Charan Panda**
  Member,Kalinga Institue of Technology &
  Design, Bhubaneswar
- **Representatives from KIIT**
- **Dr. R. N. Ray**
  Chairman, NCSTC Network,
  New Delhi **Convener**

Media

- **Sri P.K. Samal**
  Chairman, Kalinga Institue of
  Technology & Design;
  Joint Managing Trustee,
  Kalinga Foundation Trust &
  Hon,ble Minister, Govt. of Odisha,
  Bhubaneswar **Chairman**
- **Dr. Pramod Kumar Mohapatra**
  Executive Editor, The Samaj, Cuttack
- **Sri Bimal Das**
  Secretary- cum-Treasurer,
  Kalinga Foundation Trust, Bhubaneswar &
  Convener, Reception Committee
- **Sri Madhu Mohanty**
  Managing Director, Dainik Bhaskar
  (Odia Daily News Paper),
  Bhubaneswar **Convener**





A Brief History of Kalinga Foundation Trust, Bhubaneswar

Kalinga Foundation Trust (KFT) was founded by the Legendary Late Sri Biju Patnaik, Hon'ble former Chief Minister of Odisha and former Union Minister, Govt. of India. The innovative idea of extracting petrol from coal was the brain child of Shri Patnaik and he implemented this project through KFT by sending six bright meritorious young Indian students to Paris for research on the subject. The objectives of the society are Public Charitable & Literary, viz: To diffuse useful knowledge in arts, science, scientific research, engineering, technology and promotion of literature, political education and allied subjects both inside and outside the Indian Union; To organize relief works in times of flood, famine, earthquake, cyclone, fire, tempest, epidemic and such other calamities; To promote, encourage foreign studies and researches by Indian students; To provide medical and welfare facilities and other amenities to children, disabled and infirm persons, the destitute and the orphans; To make arrangements for poor and deserving persons for free medical treatment and to provide stipends, scholarships, grants for enabling meritorious and deserving students to prosecute higher studies in India or abroad etc. All the above objectives are being implemented by KFT for the last 60 years.

For details, the Website of Kalinga Foundation Trust (www.kalingafoundationtrust.com) may please be referred.



"In my Dream of the 21st Century for the state of Orissa , I would have young men and women who put the interest of the state before them. They will have pride in themselves, confidence in themselves. They will not be at anybody's mercy, except their ownselves.By their brain,intelligence and capacity, they will recapture the history of Kalinga.I would like my Orissa of the 21st century to have excellent artisans, superb craftsmen and cculptors, greatest musicians and poets."

Biju Patnaik

Shri Biju Patnaik,
Founder President, Kalinga Foundation Trust

UNESCO's International Prizes in Science
United Nations Educational Scientific and Cultural Origanisation (UNESCO)

International Partnership in Science

Unesco Kalinga Prize for the Popularization of Science

The Unesco Kalinga Prize for the Popularization of Science is an international distinction created by UNESCO in 1952 following a donation from Mr. Bijoyanand Patnaik(Biju Patnaik), Founder and President of the Kalinga Foundation Trust in India.

The recipient of this annual award must have distinguished him or herself during a brilliant career as writer, editor, lecturer, film producer radio/television programme director or presenter, through his/her talent in interpreting science and technology for the general public. The recipient should have striven during the course of his/her career to emphasize the international importance of science and technology and the contribution they make to improving public welfare, enriching the cultural heritage of nations and solving problems facing humanity. Many past Prize Winners have been scientists in their own right, while others have been trained in journalism or have been educators or writers.

Each Members State is entitled to nominate a single candidate, through its National Commission for UNESCO,on the recommendation of the national associations for the advancement of science or other science associations, or national associations of science writers or science journalists. Applications from individuals are not accepted.

The laureate is selected by the Director-General of UNESCO upon the recommendation of a four-member jury designated by him. Three members of the Jury from different countries of the world are designated on the basis of equitable geographical distribution and the fourth on the recommendation of the Kalinga Foundation Trust.

The Kalinga Prize is awarded during the Celebration of the World Science Day (2003, 2005, etc.) and in New Delhi, India, in even years. Under the terms of the Prize, the recipient receives the sum of 20,000 US$, a UNESCO Albert Einstein Silver Medal & a Citation. The recipient is also awarded the Kalinga Chair introduced by the Govt. of India to mark 50th Anniversary of UNESCO Kalinga Prize. As holder of Kalinga Chair, the Winner travels to India for a period of two to four weeks as the guest of the Govt. of India . The Chair also comprizes a token honorarium of USD 5,000. In the years when the award ceremony take place during the celebration of the World Science Day, the recipient travel to the city where the science day celebrate (2003 in Budapest) as the guest of UNESCO, in the years when it is awarded in New Delhi, the recipient is invited, as the guest of the Kalinga Foundation Trust, to undertake a brief lecture tour in India. For this reason, it is preferable that the recipient be proficient in English.

Who may apply:

- Writers, editors, lecturers, radio/television programme directors or film producers who have devoted their career to interpreting science, research and technology for the general public;
- the applicant does not need to have a science degree
- this prize does not reward research
- this prize does not reward formal teaching (in a school, university) nor curriculum development for the formal learning sector
- candidates are proposed by their Government through the National Commission for UNESCO.
- Each National Commission for UNESCO proposes a candidate on the recommendation of the national associations for the advancement of science or other science associations, or national associations of science writers or scientific journalists
- Each National Commission for UNESCO may propose a single candidature consisting of an individual only
- candidatures sent directly to UNESCO by individuals will not be accepted.

How to apply:

- do not apply directly to UNESCO; contact your National Commission for UNESCO to make known your interest in being your country's candidate for this prize;
- If you belong to a national association for the advancement of science or any other science or any other science association or to an association of science writers or scientific journalists, make known

to it your interest in applying for this prize

- this was an annual prize till 2005. From 2006-2008, statute & financial guidelines were being revised. Since 2009, the prize is given bi-annually.
- checklist
- your application needs to contain the following items (in English or French in four copies)
- Curriculum vitae
- completed submission sheet (French/English)
- description of your major achievements in science popularization
- annexes supporting your career in science popularization. These may be books, CD-ROMs destined for the general public, newspaper articles, videocassettes of films or televivision programmes you have made, brochures of public exhibitions you have organized, etc.(Please note that if an official translation of your work into English and/or French does not exist, it is in your own best interests to supply a detailed explanation in English or French of the content of each annex or a partial translation).

The Kalinga Prize for the Popularization of Science is administered bythe Science Analysis and Policies Division.

For further information , write to:

Yoslan Nur
Programme Specialist
Division for Science Policy & Sustainable Development
Natural Sciences Sector
United Nations Educational, Scientific & Cultural Organisation (UNESCO)
1, rue Miollis, 75732, Paris cedex 15 France
Tel: + 33 (0) 1 45 68 39 17
Fax: + 33 (0) 1 45 68 58 27
e.mail: y.nur@unesco.org
Website : http:// www.unesco.org

International Partnership in Science

UNESCO Kalinga Prize for the Popularization of Science

Submission Form

This form is to be submitted to UNESCO solely by the National Commission for UNESCO in the candidate's home country

1 Name of the Member State submitting the candidature:

2. Name of the body proposing the candidature (if appropriate):

3. Candidate(s)' full name and nationality:

   First name...Last name:...

   Nationality:.. Birth Date:...

4. Address:...

   ....

   Town.......................................Country.......................................Postal Code..................................

5. Contacts:

   Telephone:...Fax Number:...

   E-mail:.. WebSite:..............................

6. List enclosed annexes (books, CD-ROMs, videocassettes, newspaper articles, etc.)

7. List translations/summaries of annexes in English and/or French (if originals in another language)

8. Description of the candidate's career in science popularization (use as many sheets as necessary):

For further information, write to: y.nur@unesco.org

UNESCO Kalinga Prize for Popularization of Science
Einstein Silver Medal



Front View of the Medal



Back View of the Medal

An Asteroid Named "Kalinga"

UNESCO PRESS

New Delhi, 27 September- On the occasion of 50th anniversary of the establishment of the Kalinga Prize, the International Astronomical Union through its commission of Minor Planet Nomenclature has decided to name minor planet (i.e. asteroid) no. 26214 "Kalinga".

The asteroid was discovered in 1997 by the Czech astronomer Dr. Petr Pravec from the Ondrejov Observatory of the Czech Academy of Sciences. The total number of asteroids discovered from Ondrejov is 152.

Kalinga is at a distance of 2, 946 Astronomical Units (AU) from the earth. An AU is equivalent to 149,597,871 kilometres.

UNESCO Kalinga Prize for Popularization of Science

List of UNESCO Kalinga Laureates



Louis de Broglie

UNESCO Kalinga Prize - 1952
Nobel Prize - 1929

Country
France





Julian Huxley

UNESCO Kalinga Prize - 1953

Country
United Kingdom/ Royaume-Uni

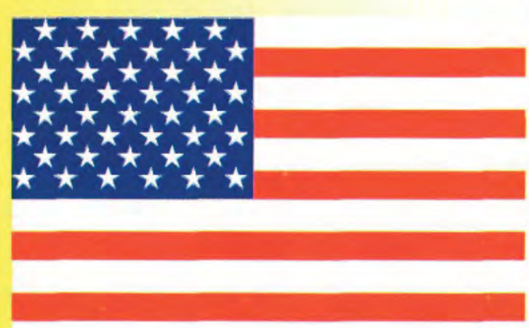




Waldemar Kaempffert

UNESCO Kalinga Prize - 1954

Country
USA/Etats-Unis





Augusto Pi Suner

UNESCO Kalinga Prize - 1955

Country
Venezuela

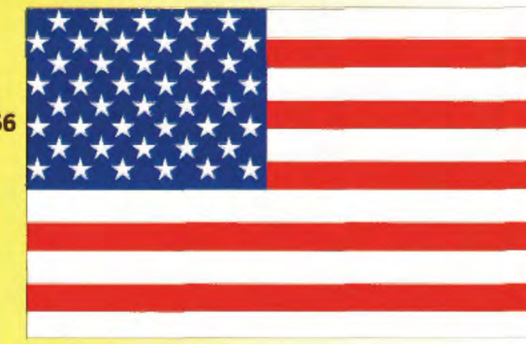




George Gamow

UNESCO Kalinga Prize - 1956

Country
USA/Etats Unis





Bertrand Russel

UNESCO Kalinga Prize - 1957
Nobel Prize, 1950

Country
United Kingdom/
Royaume-Uni





Karl von Frisch

UNESCO Kalinga Prize - 1958
Nobel Prize, 1973

Country
F.R. Germany
/R.F. d'Allemagne





Jean Roastand

UNESCO Kalinga Prize - 1959

Country
France





Ritchie Calder

UNESCO Kalinga Prize - 1960

Country
United Kingdom/ Royaume-Uni





Arthur C. Clarke

UNESCO Kalinga Prize - 1961

Country
United Kingdom/ Royaume-Uni





Gerard Piel

UNESCO Kalinga Prize - 1962

Country
USA/Etats Unis





Jagjit Singh

UNESCO Kalinga Prize - 1963

Country
India/Inde

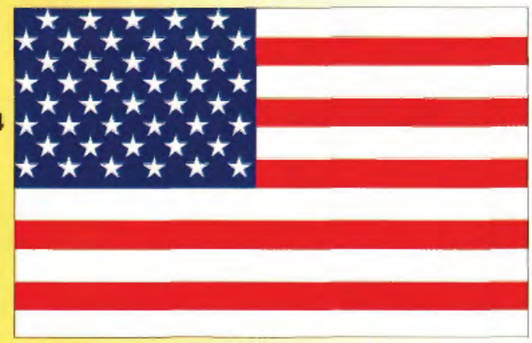




Warren Weaver

UNESCO Kalinga Prize - 1964

Country
USA/Etats Unis

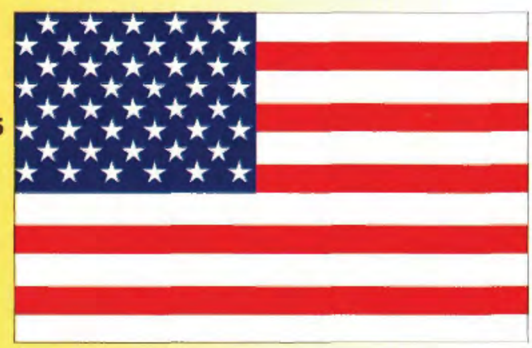




Eugene Rabinovitch

UNESCO Kalinga Prize - 1965

Country
USA/Etats Unis





Paul Couderc

UNESCO Kalinga Prize - 1966

Country
France





Fred Hoyle

UNESCO Kalinga Prize - 1967

Country
United Kingdom/
Royaume-Uni



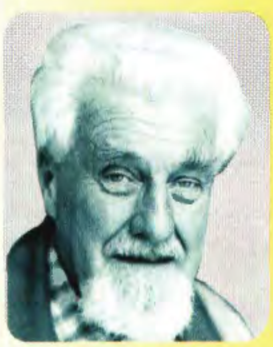


Gavin de Beer

UNESCO Kalinga Prize - 1968

Country
United Kingdom/
Royaume-Uni





Konrad Lorenz

UNESCO Kalinga Prize - 1969
Nobel Prize - 1973

Country
Austria/Autriche

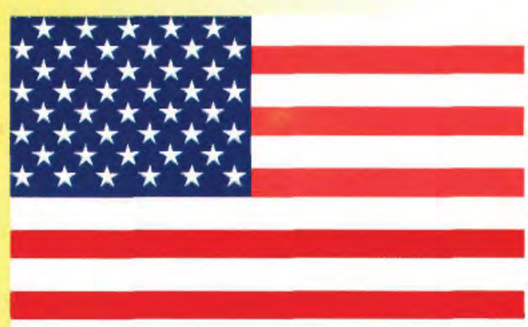


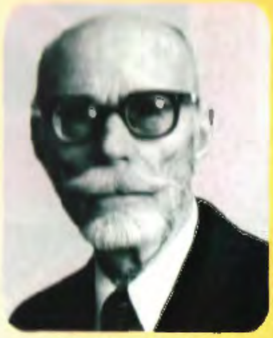


Margaret Mead

UNESCO Kalinga Prize - 1970

Country
USA/Etats Unis





Pierre Augier

UNESCO Kalinga Prize - 1971

Country
France

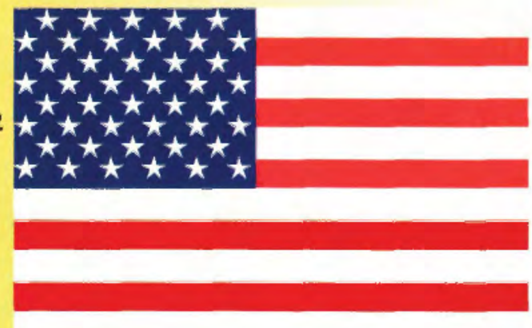




Philip H. Abelson

UNESCO Kalinga Prize - 1972

Country
USA/Etats Unis





Nigel Calder

UNESCO Kalinga Prize - 1972

Country
United Kingdom/
Royaume Uni



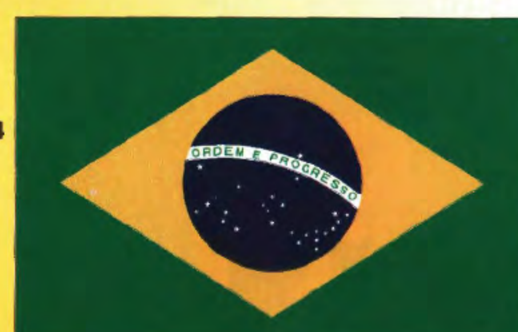
1973 Not Awarded



José Reis

UNESCO Kalinga Prize - 1974

Country
Brazil/Brésil





Louis Estrada

UNESCO Kalinga Prize - 1974

Country
Mexico/Mexique



1975 Not Awarded



George Porter

UNESCO Kalinga Prize - 1976
Nobel Prize - 1967

Country
United Kingdom/
Royaume-Uni





Alexander Oparin

UNESCO Kalinga Prize - 1976

Country
USSR/URSS





Fernand Seguin

UNESCO Kalinga Prize - 1977

Country
Canada





Hoimar von Ditfurth

UNESCO Kalinga Prize - 1978

Country
F.R. Germany/
R.F. d'Allemagne





Sergei Kapitza

UNESCO Kalinga Prize - 1979

Country
USSR/URSS





Aristides Bastidas

UNESCO Kalinga Prize - 1980

Country
Venezuela





David F. Attenborough

UNESCO Kalinga Prize - 1981

Country
United Kingdom/
Royaume-Uni

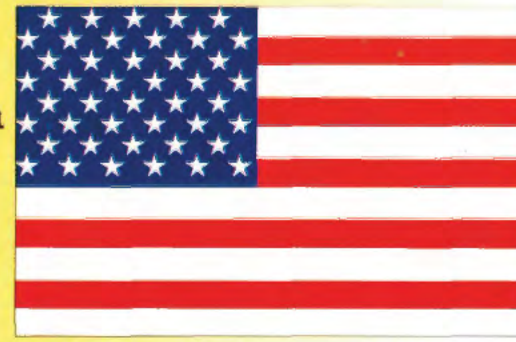




Dennis Flanagan

UNESCO Kalinga Prize - 1981

Country
USA/Etats Unis





Oswaldo Frota-Pessoa

UNESCO Kalinga Prize - 1982

Country
Brazil/Brésil





Abdullah Al Muti Sharafuddin

UNESCO Kalinga Prize - 1983

Country
Bangldesh

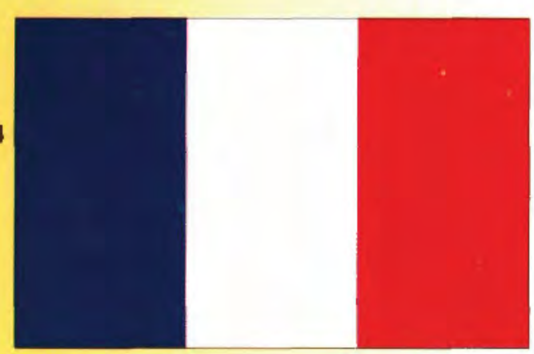




Yves Coppens

UNESCO Kalinga Prize - 1984

Country
France



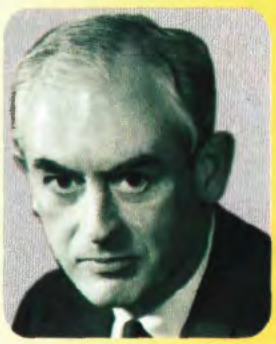


Igor Petryanov

UNESCO Kalinga Prize - 1984

Country
USSR/URSS





Sir Peter Medawar

UNESCO Kalinga Prize - 1985
Nobel Prize - 1960

Country
United Kingdom/ Royaume-Uni





Nicolai G.Basov

UNESCO Kalinga Prize - 1986
Nobel Prize - 1964

Country
USSR/URSS





David Suzuki

UNESCO Kalinga Prize - 1986

Country
Canada



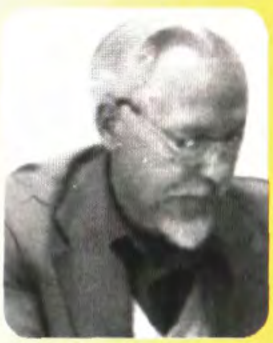


Marcel Roche



UNESCO Kalinga Prize - 1987

Country
Venezuela



Björn Kurtén



UNESCO Kalinga Prize - 1988

Country
Finland/Finlande



Saad Ahmed Shabaan



UNESCO Kalinga Prize - 1989

Country
**A.R. of Egypt/
R.A. d'Egypte**



Misbah-Ud-Din Shami



UNESCO Kalinga Prize - 1990

Country
Pakistan



Radu Iftimovici

UNESCO Kalinga Prize - 1991

Country
**Romania/
Roumanie**





Narender K. Sehgal

UNESCO Kalinga Prize - 1991

Country
India/Inde





Jorge Flores Valdés

UNESCO Kalinga Prize - 1992

Country
Mexico/Mexique





Peter Okebukola

UNESCO Kalinga Prize - 1992

Country
Nigeria/Nigéria





Piero Angela

UNESCO Kalinga Prize - 1993

Country
Italy/Italie





Nikolai N. Drozdov

UNESCO Kalinga Prize - 1994

Country
Russia/Russie





Julieta Fierro Gossman

UNESCO Kalinga Prize - 1995

Country
Mexico/Mexique





Jiri Grygar

UNESCO Kalinga Prize - 1996
Country
Czech Rep./Rep. Tchèque





Jayant V. Narlikar

UNESCO Kalinga Prize - 1996

Country
India/Inde





Dorairajan Balasubramanian

UNESCO Kalinga Prize - 1997

Country
India/Inde





Regina Paz Lopez

UNESCO Kalinga Prize - 1998

Country
Philippines





Ennio Candotti

UNESCO Kalinga Prize - 1998

Country
Brazil/Brésil





Marian Addy

UNESCO Kalinga Prize - 1999

Country
Ghana





Emil Gabrielian

UNESCO Kalinga Prize - 1999

Country
Armenia/Arménie





Ernst W. Hamburger

UNESCO Kalinga Prize - 2000

Country
Brazil/Brésil





Stefano Fantoni

UNESCO Kalinga Prize - 2001

Country
Italy/Italie





Marisela Salvatierra

UNESCO Kalinga Prize - 2002

Country
Venezuela





Pervez Amirali Hoodbhoy

UNESCO Kalinga Prize - 2003

Country
Pakistan

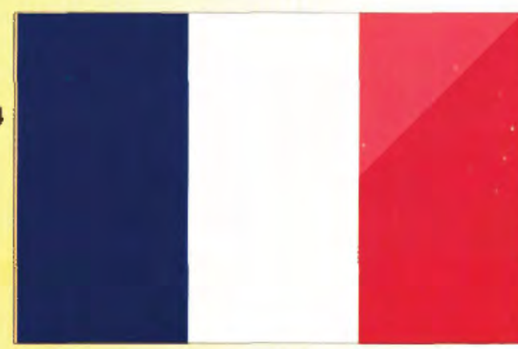




Jean Audouze

UNESCO Kalinga Prize - 2004

Country
France





Jeter Jorge Bertoletti

UNESCO Kalinga Prize -2005

Country
Brazil / Brésil



2006 – 2008 Statute & financial guidelines were being revised



Yash Pal

UNESCO Kalinga Prize - 2009

Country
India/Inde





Trinh Xuan Thuan

UNESCO Kalinga Prize - 2009

Country
Vietnam





René Raul Drucker-Colín

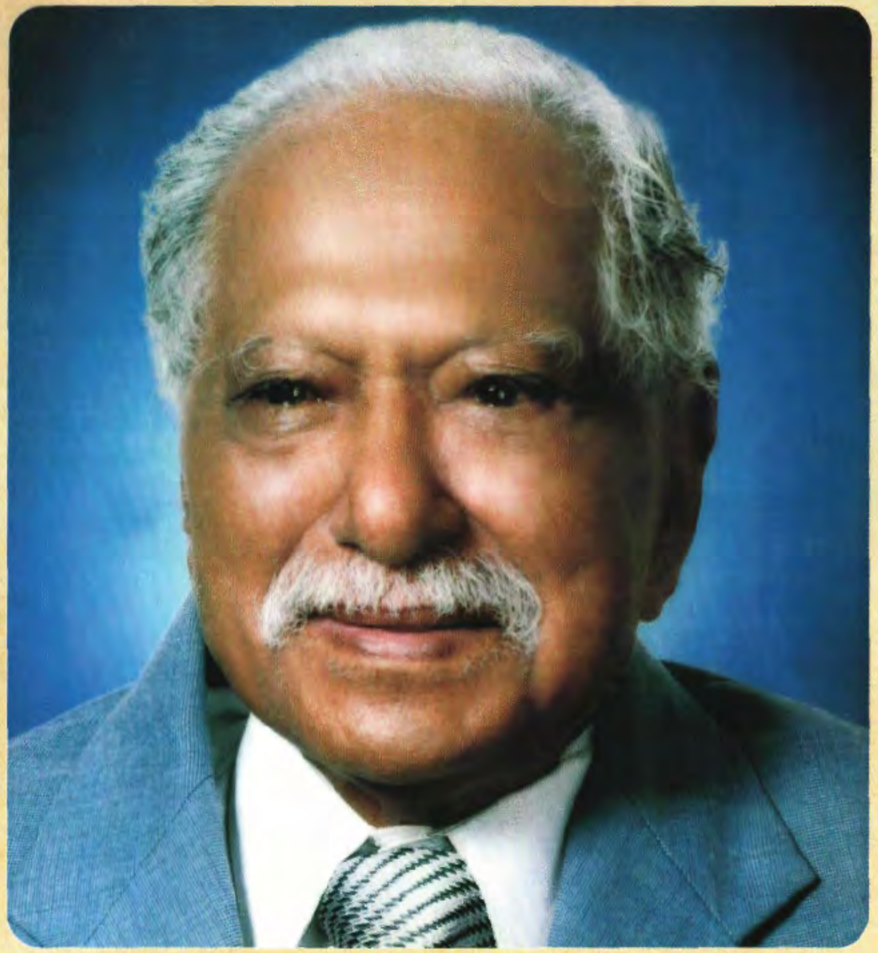
UNESCO Kalinga Prize - 2011

Country
Mexico/Mexique



For further information , write to:

Yoslan Nur
Programme Specialist
Division for Science Policy & Sustainable Development
Natural Sciences Sector
United Nations Educational, Scientific & Cultural Organisation (UNESCO)
1, rue Miollis, 75732, Paris cedex 15 France
Tel: + 33 (0) 1 45 68 39 17, Fax: + 33 (0) 1 45 68 58 27
e.mail: y.nur@unesco.org
Website : http:// www.unesco.org



Late Kamini Kanta Patnaik
Founder Member &Managing Trustee
Kalinga Foundation Trust,Bhubaneswar
(1st March, 1921 - 11th July,2011)

CONDOLENCE MESSAGE

We, the Members of the Kalinga Foundation Trust, Bhubaneswar, are very much aggrieved by the sad demise of Sri Kamini Kanta Patnaik, Founder Member and Managing Trustee of Kalinga Foundation Trust, who left for his heavenly abode on 11th July, 2011 on the most auspicious day of **"Bahuda Yatra"** of **Lord Jagannath**, the Lord of the Universe. Let his soul rest in peace. We pray before the almighty for the same. Let Lord Jagannath provide necessary strength of mind to his bereaved family members to bear one of the saddest evenst of life.

Sri Kamini Kanta Patnaik was a Pillar of Strength for the Kalinga Foundation Trust. He was a Friend, Philosopher and Guide to all of us-. His immense love for Popularization of Science for the Masses and his long association with Late Sri Biju Patnaik, Founder of Kalinga Foundation Trust and UNESCO Kalinga Prize will be cherished for time to come. Kalinga Foundation Trust will remember him for his praiseworthy contribution for establishing Kalinga Institute of Technology and Design (KITD) and **"Kalinga Samman"** for Popularization of Science.

Sri Kamini Kanta Patnaik was a Noted Social Worker, Eminent Lawyer and Founder of Orissa Engineering College,the First Private Engineering College in Odisha. He will be remembered for his great contributions as an Architect of Social Reform, Educational Acumen and Scientific Sprit which will guide the future generations in time to come.

Let his soul rest in peace.

Bhabani Charan Pattanayak

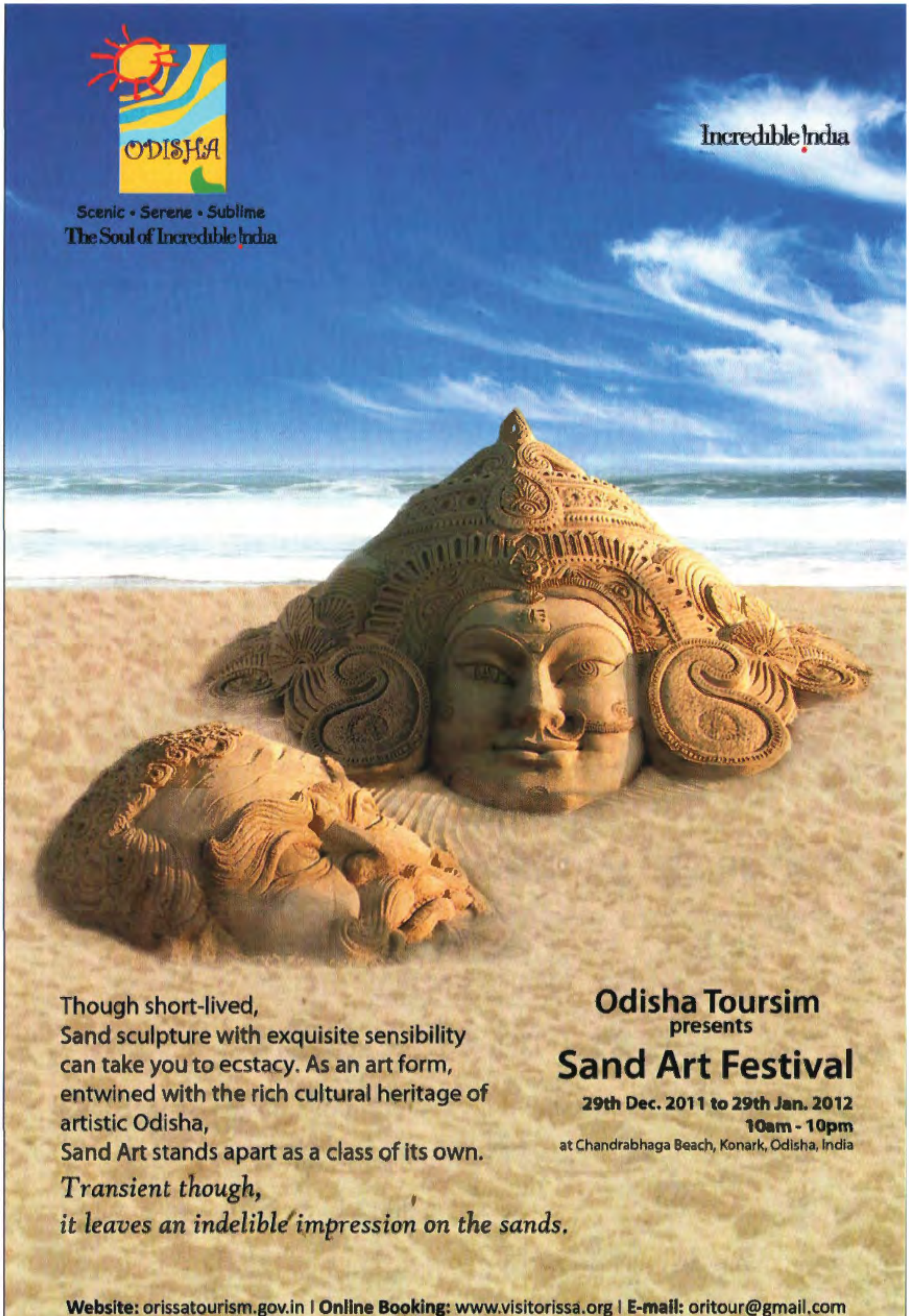
(Bhabani Charan Pattanayak)
Chairman
Kalinga Foundation Trust, Bhubaneswar

Contents

Science Journalism

Science Popularization: Way Forward




ODISHA
Scenic • Serene • Sublime
The Soul of Incredible India
Incredible India
Though short-lived,
Sand sculpture with exquisite sensibility
can take you to ecstacy. As an art form,
entwined with the rich cultural heritage of
artistic Odisha,
Sand Art stands apart as a class of its own.
Transient though,
it leaves an indelible impression on the sands.
Odisha Toursim
presents
Sand Art Festival
29th Dec. 2011 to 29th Jan. 2012
10am - 10pm
at Chandrabhaga Beach, Konark, Odisha, India
Website: orissatourism.gov.in | Online Booking: www.visitorissa.org | E-mail: oritour@gmail.com
Toll Free: 1800 2097 123 | OTDC Central Reservation Counter : Tel. : +91 674 2430764

Global Challenges on Popularization of Science

Orissa Engineering College

STANDS FOR QUALITY EDUCATION

www.oec.ac.in





Orissa Engineering College (OEC) is celebrating 25 years of its existence. It is the first private engineering college to be established in Orissa way back in 1986. Orissa Engineering College is the result of the vision of Shri Kamini Kanta Patnaik who laid the foundation of what is today one of the best technical institutes in the state. OEC is a part of Nabajyoti Charitable Trust's endeavour to provide quality education.

Orissa Engineering College is affiliated to the Biju Patnaik University of Technology (BPUT). It has been approved by AICTE (All India Council for Technical Education).

FACILITIES

1. College Campus spread over 50 acres of land in a pollution free environment.
2. Special Training Programmes at City Campus (460, Saheed Nagar)
3. Training & placement cell supporting in-campus recruitment by branded corporate houses
4. Teachers students ratio 1:15
5. Fully equipped Internet Connectivity (384 Kbps leased line)
6. Highly Qualified and Experienced Faculty
7. Open Stock system library
8. Wireless LAN facility in campus
9. Personality Development & Communication Skill programmes
10. Proctorial System and Tutorial facility
11. Visiting delegates from IIT and industrial sector
12. Excellent hostel and efficient transport facility
13. In Campus Dispensary with Ambulance facility
14. Industry institution relationship
15. High Profile Placement
16. Exposure to live projects
17. Strong Alumni base
18. Highly equiped R & D cell
19. Delnet facility for students
20. Biju Patnaik Computer Center

Courses Offered

B.Tech

Electronic & Telecommunication
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Popularization of Science: Its Glory and Pitfalls

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Almost 15 years elapsed from my previous visit to Bhubaneswar and in the meantime we have experienced many advances in the scope and speed of the communications that affect profoundly science, its popularization and our everyday lives as well.

Although the first e-mail between two computers in California was sent already in 1969, the famous WWW protocol was invented only 20 years ago and Google search engine started in September, 1998. Now we have Twitter, Facebook and other social networks; radio and TV programmes are available in real time or from huge archives and the transmission capacity of optical cables seems to be nearly unlimited. Cell phones made the personal communication so easy that many people almost stop reading. According to recent poll young people in Europe prefer internet access over owning a car.

However, science and technology knowhow behind this communication revolution is a domain of rather small segment of human population. Almost nobody realizes that these formidable means of communication are based In the great physical revolution started in 1897 by the discovery of electron and followed by the advances of atomic and nuclear physics and by the simultaneous achievements in theory, namely quantum mechanics and relativity. Grounded on this knowledge information theory and cybernetics flourished and in this way the road was opened towards the present state of world-wide communication society.

In my opinion it is now an important task of popularizing science to remind young generation about these roots and to inspire bright youngsters to choose for careers in science and technology. We have to be frank in exposing that such career is not very easy one. Studying science is a hard work requiring a high degree of dedication.

The advances of information technology bring to every scientist a good deal of experimental data, now in petabyte domain and the same is true about the flood of good papers published in peer-reviewed journals. The proverbial maxim *"Publish or perish"* represents a constant challenge particularly to young scientists especially in those projects where hundreds of experts should collaborate on having the paper published in renowned journals.

Thus, getting an adequate and tenured job after long studies is not guaranteed. However, we have to stress to the gifted young men and women that although the stakes are high, the rewards are even higher. Good science is an adventure of seeking for the knowledge, indeed. Every society that wishes to preserve or improve its overall prosperity has to follow the advice by Benjamin Franklin: *"An investment in knowledge always pays the best interest".*

On the other hand browsing the internet reveals just the opposite story. Since its beginning the internet was and still mostly is rather free medium. Everybody who masters the basic internet skills can openly expose his or hers opinion, data, pictures, music, videos etc. Censorship exists in some countries but peer review of internet information is virtually non-existent.

Thus, overall contents of the internet information is imprecise, dubious, plain wrong, 'not even wrong', deceiving and deliberately false. Most users are unable to discriminate between reliable, unreliable, false, and totally useless information. This is the most dangerous pitfall of beautiful modern medium that adversely affects also the popularization of science among general public.

Internet is also the source of a lot of prejudices and wrong thoughts towards science and technology. Many people including some U.S. citizens believe that NASA project Apollo was executed in Hollywood studios, or that WTC Twins in New York were dynamited by CIA agents. In the same vein HIV virus was supposed to be accidentaly or even deliberately leaked off the secret military laboratory for biological warfare. Similarly, some people tried to sue CERN laboratory in Switzerland because they feared that the new accelerator LHC could produce a black hole that swallows the Earth.

In the internet webpages you may find frequent praises of astrology, homepathy, close encounters of n-order with the extraterrestrials, psi powers and of many other sorts of pseudoscience or pseudotechnology (cf. alleged Nikola Tesla's experiments with beams of strong electromagnetic energy that get out and caused a Tunguska explosion in 1908, or claims that U.S. Alaskan project HAARP for studying the ionosphere is dangerous and should be stopped).

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New Approach of Scientific Creativity and Science Education for the Gifted in Korea

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As the societal needs of creative human resources drastically increase in the era of rapidly developing science and technology, many countries around the world strive their educational efforts for developing top-rank creative human resources in the areas of science technology. Gifted education in science has been recognized as one of the ways to prepare for it. Korea, as a nation mostly depending on advanced development of science and technology for its economic growth and competitiveness, has to inevitably invest in gifted education in science.

Science education for the gifted in Korea had not gathered much attention until a science high school was established in 1983. The first science high school was designated under the education law of K-12 for the special purpose of providing high school education with emphasis on science and science related career education. It was considered as the first effort made under the government policy by the Ministry of Education. In consecutive years, more science high schools were established and there are 20 science high schools with student enrollment of about 3,000 in 2010.

Recently, the Ministry of Education, Science and Technology strengthened the importance of expanding science education for the gifted. As results, in 2003, Korea Science Academy was opened with 144 students selected nationwide and three science academies, Seoul Science Academy (opened in 2008 and 121 students enrolled in 2011 as 10th graders), Taegu Science Academy (in 2010, 97 students), and Gyunggi Science Academy (in 2009, 135 students) were added after. Currently, in addition to 20 science high schools, four science academies in Korea have enrollment of 497 highly gifted and talented students in science who were screened nationwide and admitted as 0.08% out of total student population at schooling age.

Science education for the gifted in Korea has faced new aspects. First, the highly gifted and talented students in science are necessarily served with effective methods of enhancing scientific creativity. Second, scientific creativity for the cutting edge development of science and technology should be combined with and connected to other areas in terms of consilience.

In the presentation, scientific creativity will be introduced from a theoretical point of view and compared with artistic creativity. An attempt will be made to connect scientific creativity to artistic creativity with placing technology and engineering in the middle of two sides and overarching with mathematics across as subject matters. It can be called as STEAM (science-technology-engineering-art-math) education. Whereas scientific and artistic creativity seem to be less functional, creativity in technology and engineering including design has functional elements. Further, teaching scientific inquiry will be also discussed in parallel to art education.

POPULARIZATION OF SCIENCE: WHAT, WHY AND HOW?

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ABSTRACT:

If philosophy and benefit of science is to be passed to the public, it is important that the later have a basic general understanding of science. For this, popularization of science is absolutely required. In this paper the reason for and the ways of popularization of science have been described. Role of scientists and science popularizers is most significant in this endeavour.

1. WHAT IS POPULARISATION OF SCIENCE?

"Popularisation of science" has different meanings for different people. It is found that thoughts, views and convictions on the meaning of popularization of science vary widely even among the popularizers on science. Some define it on their ideas of the very purpose of popularizing science. While others define it how it would benefit the target groups.

The general perception of popularization of science is to present the complex theories of science in a very simple and easy language before the people. According to Gustaaf C. Cornelis, Brussel University, Belgium, 'Popularization of science is nothing else than an endeavour to image scientific ideas in such a way that everyone (especially non-scientists) can grasp the fundamental concepts and have an idea of what science in essence is" The way of presentation is such that even a person who has not studied science in school or college can understand it. It aims at making awareness and understanding of science at a very common level.

2. WHY POPULARIZE SCIENCE?

There are many reasons why science should be popularized among common people in general and children in particular.

a) To explain scientific matter in simpler way

The first and foremost reason for popularization of science is to explain the meanings and ideas of a particular subject so that everyone can understand it. In this connection we must know what science is. Science is special knowledge on any subject. Man has acquired knowledge by observing nature and natural objects and has tried to know the reasons behind the natural happenings surrounding him. For this, he has to do certain experiments and observations and from this he has derived certain inferences and hypothesis. From this the physical laws governing our universe are derived. Gradually science was developed and is branched into physics, chemistry, botany, zoology or geology each with its own principles, laws and rules. Science has become now codified and highly specialized. Science is being used in various applications, which include technology, health, commerce and everyday activities. One byproduct of this is that the language of science has become complex, more technical and far from the everyday familiarity of the common man. The distance between the scientist at research laboratories and common man at large is widening because science and technology is developing its own idioms and specialized approaches.

The scientists publish their findings in specialized journals of their own profession or association. It is very difficult for the common man to get the journal and understand it. It is also not possible for the common man to read the original works of a scientist. Further, the scientists generally write the books or articles meant for people of their standard and class.

It is learnt that when Albert Einstein wrote his "Theory of Relativity", very few people could understand it. Even many people of science were unable to grasp it. It is because the theory was very complicated and it was written in complex language. It is happening because scientists find little time to write their work for common man.

Of course, there are some scientists who write in a simple manner. One such example is Charles Darwin who propounded the "Theory of Evolution". His famous book "The Origin of Species" is written in such a simple and literary style that there is no need for further simplifying it for common man. It became popular overnight after its publication. Other scientists and naturalists who fall in this category are Mendel and Benjamin Franklin. But this category of scientists is very rare.

It is in this context that it has become necessary for popularizing science and making it available and understandable to the layman. The feeling behind this is that science should not be an alien subject, but part of the human experience. As science has become the part and parcel of human activity in recent years everyone should be able to know the theories behind it.

b) To increase scientific literacy

Another aspect of popularization of science is to enhance scientific literacy among masses. Common people can derive benefits resulting from advances already made or being made in science and technology if the level of scientific literacy among them is raised to a certain minimum level. For

example, the farmers can know the improvement made in farming sector if they are explained the scientific facts behind it. Science literacy is vital to society, if one is to reap the best in life and be an active member of the society. Rising of scientific literacy among people can be only through science popularization efforts.

c) ***Removal of superstition.***

In India and also in many third world countries majority of the people live in villages and many of them are illiterate. There are many superstitions, blind beliefs and unhealthy traditional practices prevailing in their activities. Even at the twenty first century people in some areas do not believe cholera, chicken pox, smallpox etc. as diseases. Instead of going to hospital, they use unhealthy practices of going to temples for cure. A natural phenomenon such as appearance of comet makes them fear. People do not come out during solar and lunar eclipses. Even some literate and educated people practice this.

Science popularization is necessary to remove the blind belief, superstition etc. from the minds of the people and thus to establish a modern society.

d) To create enthusiasm among children

Many children do not take up science course in higher education. They have some inherent fear that the subject is different and some even think it boring. Science popularization is necessary among young students to excite and enthuse them to take up scientific and technical carriers including research activities.

e) To remove wrong concepts regarding science

There are some wrong conceptions regarding science in the minds of people. They think that science is responsible for degradation of environment and it is doing more harm to the society than good. Some believe that human life may come to an end in our earth in near future due to science.

Use of science and technology has created some confusion and controversies in the minds of laymen. One example is computerisation of banks. When computerisation in banks started, there was fear in the minds of the employees that they would be retrenched from service. But after explaining them the use of computer for efficient performance of the banking system, and not for reducing manpower, the controversy died down. Similar fears were also seen while using computer in railway reservation and different government offices. There are so many examples. When Hirakud dam was built on the river Mahanadi during 1950s, rumour was spread by vested interested people that water after being used for generation of electricity would lose its properties and would not be fruitful for irrigation. Some people believed it and joined the protest against the dam. Even now some people believe that children are gifts of God and so they oppose family planning program. Likewise controversies are surfacing in case of atomic power plant and big dams.

However, it must be emphasized that in terms of absolute numbers, only a miniscule fraction of the population may be involved in such protests, and that too for reasons that have less to do with science and technology. In fact, some accidents such as Bhopal gas tragedy and Chernovil nuclear explosion have tempted some to take anti-science and anti-technology stance. The recent Fukushima nuclear power plant explosion in Japan due to earthquake and tsunami added fuel to this.

Hence, science popularization is necessary to remove the wrong perceptions regarding use of modern technology from the minds of common people.

f) To let students know science matters outside their text books

Students are given some fixed topics for their syllabus keeping in mind the time duration available for the course. Teachers also generally do not teach beyond that. Students can be given some additional science topics. This can be presented in a simple way so that they can understand without the help of the teachers.

In short it can be said that science popularization should be done for stimulation and promotion of scientific temperament, attitude and outlook among the people. In other words, science popularization is necessary for learning the methods and values of science and getting up to date understanding of science among the general people.

3. HOW TO POPULARISE SCIENCE

Popularization of science can be done in various ways depending on the target group.

i) The best way of popularization of science is to write the complicated theories in simple language, which can be understood by the common people. For this, the scientists have a major role to do. They know very well the theories of science in which they are involved. So they can explain it properly. Hence they should be persuaded to write popular science. Some of the great scientists are simultaneously rated as popular science writers. The great theoretical physicist Stephen William Hawking of Great Britain is one of them. His book "A Brief History of Time" is a best seller almost in every country. Dr. Carl Sagan, an outstanding American astrophysicist was also an outstanding science popularizor. His writings and television programs have enriched the people of the world. In our country the astrophysicist J. V. Narlikar is a glaring example of science popularizor for which he was awarded the Kalinga Prize by UNESCO for the year 1996.

ii) Apart from scientists, the lovers of science can be very good science popularizers. They can write the scientific theories in simple language understandable by the students of non-science. Science teachers and technocrats can become the medium for popularizing science. Even persons

who have not studied science in college and are not working in the field of science can write about science if they take interest. One glaring example is Binod Kanungo, the pioneer behind preparing "Gyan Mandal", an encyclopedia in Oriya language. Though not a man of science, he has written a lot of popular books on science for the children.

It is seen that some science writers add some false facts with true ones to make it more interesting, funny and attractive. But it hampers the real purpose and so it is the duty of science popularizers to discard the bogus things from his writings. Also sometimes the writer may mislead the readers due to his ignorance of the true facts. To avoid this he should be in constant touch with science, preferably as a practitioner or as an analyst of scientific ideas and facts.

iii) Science magazines both in English and regional languages should be published for popularization of science. It is seen that science magazines are stopped publishing after some issues due to financial problems. Now in national level, only one noted science magazine "The Science Reporter" is being published. Others such as "The Resonance" are not circulated much due to high cost. Private publishers are reluctant to publish science magazines from economic reason. So, government should give monetary help to these publications.

iv) Popular science books should be published in English as well as in regional languages. It should be at affordable prices so that students can purchase it. Further, subjects which are not in the curriculum of text books should be given priority while selecting the books. Also, scientific facts can be expressed through novels, drama, short stories and poems to create enthusiasm among readers towards science.

v) Government and non-government institutions should be established for the propagation of science. These can spread the message of science in an organized manner. One such organization is 'Vigyan Prasar' which is popularizing science by publishing magazines and books, broadcasting in radio and television etc. Many states have science academies either in government or private level for this purpose.

vi) Science exhibition and fairs should be organized for school children at block and district level.

vii) Role of electronic media is very important for popularization of science. Science matters in simple languages can be broadcast through radio station. Science experiments can be explained through television. The rise and development of the World Wide Web as a part of internet since 1990s is a significant feature for the popularization of science. Lot of scientific materials is now easily available in internet which contributes as an effective means of improving the public understanding of science.

viii) Science museums, science parks and planetariums should be established at each district headquarters so that children can understand in a better way by observing different models. Mobile exhibition vans should be arranged for the people of rural areas.

ix) Lectures by eminent scientists should be arranged for school and college students.

x) Large number of common people should be motivated to participate in the programmes and activities of science popularization which goes beyond students and school or colleges in their aim.

xi) Science popularizes should analyze and examine our age-old traditions and beliefs in different areas such as agriculture, health, education etc. The science popularizer should not have the notion that all the old traditions and beliefs are non-scientific. In fact some of these are based on scientific methods. These should be retained as such or with necessary modifications. For example, our ancient method of health care using herbal medicine i.e. ayurvedic is now recognised by western doctors, but in our own country some people have bitterness against it.

xii) In national or international level science can be propagated on a specific theme. For example, the United Nations Organization celebrated the year 2005 as International Year of Physics to commemorate the centenary of publication of Einstein's path breaking theories in 1905. People discussed about physics in general and about Einstein in particular. Similarly the year 2009 was celebrated as the International Year of Astronomy and lot of activities were undertaken in that year to popularize astronomy. Again the year 2011 is being celebrated as the International Year of Chemistry to let the people know the contributions of chemistry for human being.

xiii) Science popularizers can be encouraged by government or other organizations. Kalinga Foundation Trust is a glaring example for establishing the international award, 'Kalinga Award' in 1951 created by Sri Biju Patnaik, former chief minister of Odisha for science popularizers. It is a good sign that now Government of India and most of the state governments have established awards for this.

4. CONCLUSION

Science and technology have in some form been integral to the Indian culture and tradition for years. This should be made full use of in science popularisation. Advances in science occur rapidly and it is the duty of science popularizers to let the people know of it.

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Challenges In Science Popularization In India

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Scientific information is becoming an essential and integral part of people's daily lives. Science popularization efforts have great potential in shaping the lives of the people and making their decision more informative and rational. India has a great tradition of scientific heritage and its communication. Our ancestors have not only excelled in the fields of mathematics, astronomy, medicine, agriculture, material science etc. but also in communicating the findings of the reseach conducted in those times. In India science and technology were communicated under the garb of religious texts, first orally in the form of hymns and verses and later writing on plates of copper, on the bark of the 'Bhurja' tree and on the leaves of palm. After the invention of paper, it was widely used for this purpose. Many ancient Indian scientists wrote beautiful verses to explain various equations and complex scientific concepts. However, due to thousands years of foreign invasion and colonialism, scientific research along with science popularization activities conducted in the county hindered and remain confined to limited people. A gap between scientific knowledge and common man increased gradually.

In general, propagation of science or scientific idea through different forms of media i.e. print, radio, television, internet, folk, and other interactive media is called science popularization. Presently, in spite of well planned efforts of science popularization in India, there are a number of challenges met by science communicators. The present and future challenges in popularizing science in our country are discussed as below.

Illiteracy:

India is a country of 1.21 billion population of which 26% are illiterate. Female illiteracy rate is still high- nearly 35% of the population. The scene of Science literacy is abysmally low in the county. The world Science Report of UNESCO (1996) states that "scientific literacy, understood as an everyday working knowledge of science is as necessary as reading and writing for a satisfactory way of life in the modern world." More precisely scientific illiteracy persists in the country is hurdles to Science popularization.

Lack of access to mass media: About 30% of the population in india is below poverty line. Two third of Indian people still derive their livelihood directly or indirectly for agriculture and something related to it. More than two third constitute our rural population. Many among the poor and rural people do not have any access to mass media. The internet/ broad band penetration per thousand people in the country is too low. Science popularization activities in the county are challenged due to lack of access to mass media.

Language:

India is well known for its diversity in language. Although Hindi is national language in India, It has 22 officially recognized languages. It is believed to have 1652 mother tongues of which 33 are spoken by people over a lakh. English is also widely spoken language in the country. Most of people are well convenient in their mother tongue. Due to non availability of appropriate scientific terms, science communication in regional languages is becoming too tough. This is resulting in ineffectiveness to improve science popularization in different parts of the country.

Superstitions:

In the present time, with the spectacular development of science and technology, several new forms of superstitions are created in our country too. In 1995, there was a news flash in different parts in India that idols of Ganesh ere inking milk if offered to them by devotees. Most of the people including ministers, eminent personalities rushed to the nearby Ganesh temple to test their devotion. The new computerized horoscopes are used in place of traditional horoscopes to serve the purpose of forecasting. People blindly believe the rumours like flying saucer, Bermuda Triangle etc. Worshiping various Jantrs to change the future, wearing stones to cure diseases, buying gold in Dhanteras in order to seek divine blessing and many more are the newer forms of superstitions created in present time. Such practice is also seen in our scientific communities. It is said that ISRO scientists are paying visit of Venkateswar Temple at Tirumala to offer prayer before every satellite launch. So superstitions are ever generating in our country. This often acts as barriers on the way of science popularization.

Lack of skilled Science Communicators: Science communicators bridge the gap between common man and

science. To be a successful and effective communicator, it requires a special skill. In our country the number of efficient and trained science communicators to conduct science popularization activities is alarmingly low and insufficient. In India science communicators are not getting due incentives for conducting science popularization activities. They are also not given accreditation facilities as matter of right and even if not treated at par with other journalists. So genius science students are not showing interest to pursue science popularization as career.

Most of the science communicators are lack of command and training in English along with their mother tongues. Moreover, they are hardly sufficient to cater to the large population of the country of diverse socio cultural setup.

Although eminent indian scientists like Mahendralal Sircar, J.C.Bose, P.C. Ray, Ruchi RamSahani, Meghnad Saha, S.N.Bose, C.V. Raman, D.S. Kthari, J.,V. Narlikar, yash Pal, P.M. Bhargava, and others are known for popularizing science through books, lectures, and also news papers and TV shows, most of India scientists at large are not interested in popularizing science. They often want to sit in ivory towers. The callousness of scientists and ineffectiveness of science communicators are the most significant challenge in science popularization.

Form of Science communication: Science literature in print format is still dry and boring which fails to attract the general public towards science. Science presentations in audio media are not arousing interest of the audience on the topic. Interesting style of presentation like fiction, story, drama, poetry, satires, discussion are not found adequate space and time in the media. Science story presented in the media is not made interesting and interactive. Lack of proper format and specific forms of communication for the target groups are the reasons behind discrepancies in science popularization.

Scarcity of funds:

India being a developing country, it is struggling with the problem of infancy death, maternal death , starvation death, child labour etc. India is allocating merely 0.8 % of its GDP towards scientific Research and Development. Whereas our neighbouring rival country china's sending on scientific research is 1.5% of GDP. Other developing countries are spending over 3% GDP on R&D. Due to lack of adequate fund, science popularization activities in our country is being obstructed.

Government policies:

An effective and well defined Government policy can mobilize and encourage Science popularization activities in the country. All the scientific institutions and organizations engaged in scientific research science popularization activities can be considered for coodination. All the scientific bodies, organizations institutions should compulsorily have science popularization as one of their mandates. Special tax concession to the advertisers who give advertisement to or sponsor science programmes in various media.

Conclusions:

At present large number of science popularization initiatives are being undertaken in the country. Science writers, journalists and communicators are popularizing science among the mass in an interesting and innovative manner. Various science popularization activities are conducted at governmental level to boost scientific literacy in the country. But still the problem of ineffective science popularization persists because of the multifarious challenges. Prof. Yash Pal, the recipient of UNESCO kalinga Prize for popularization of science in 2009, says " It is true that a lot is done to promote scientific knowledge in our county, but it is not enough. The scientific awareness spreading process must take place first and foremost by contextualising the data and knowledge in to the needs of everyday life. We have to make our communication more interesting and interactive." Hence present scenario of science popularization in the country can be changed by the application of innovative ideas, methodologies and strategies. A trend of a dynamic, systematic and creative science popularization activities at a par with other western countries have to be set up in the country. All the challenges faced in science popularization initiatives have to be treated as opportunities and look for our own unique solutions.

POPULARIZATION OF SCIENCE: REACHING THE UNREACHED

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I. What Is Science?

The term science is derived from the Latin term *scientia* or *scire* the meaning of which is "knowledge" or "to know" respectively. Common people believe that science is such a thing or subject which is quite a miracle. But it is not at all a fact. Science is basically stated as follows.

1. Knowledge.
2. Knowledge ascertained by observation and experiment, critically tested, systematized and brought under general principles.
3. The systematic observation and classification of natural phenomenon in order to learn about them under general principles and laws.
4. Acquired skill or technique as opposed to natural ability.

Broadly speaking the answer to the question such as WHY, WHERE, WHICH, WHEN,WHO and HOW is science. In other words 5Ws and 1H is science. Anybody may put question for any incident or occurrence or situation or happening and the answer to these is the science.

There was a time when people believed many things and aspects blindly without any reasoning or logic. Because at that period of time, it was quite difficult to find out the answer to the situation. Gradually or slowly scientists wanted and tried their best to establish and explore the reason(s) by appropriate and concrete answers with evidence or experimental proof. So the misconception or blind beliefs are being erased from the minds of the people of our society. Even there was a time when people were and are keeping on telling as to the miracle. In fact, no such thing as miracle by name exists. There is absolutely nothing beyond science or scientific justification.

Ii.what Is Communication?

Communication is derived from the Latin term *communicare* or *communis communicatum* the meaning of which is common or to share. The common meaning of communication is as follows.

1. To impart information or ideas.
2. To make something known or understood.
3. To get in touch.
4. To pass on or transmit a feeling or disease.
5. To have a comfortable social relationship.

Broadly speaking communication is the science and activity of transmitting information or imparting ideas and information. Taking human beings into account, the communication may be (a) intrapersonal or (b) interpersonal.

There are various processes of communication which can be achieved by (i) letter (ii) signs (iii) signals (iv) words (verbal) (v) telephone (vi) telegraph (vii) teleconferencing (viii) computer (e-mail etc.) and (ix) printing. All these processes can be categorised into (a) verbal and (b) non-verbal communication. The verbal communication is possible through discussion, teaching, counselling, meeting, conference, symposia and colloquia, whereas the non-verbal communication is achieved by (a) print media and (b) electronic media. The communication by electronic media implies the various electronic processes by which information is conveyed from one person or place to another, especially by means of wire, cables or radio waves. At present electronic media is the most effective and efficient media of providing information in a short time worldwide. Learners at an early stage begin their communication through print media, i.e., through books. This is the age of information technology (IT) and the people around the world communicate or gather knowledge or send information through electronic devices like computers, laptops, palmtops etc.

Iii. Necessity Of Science Communication

Science speaks of truth and explains the absolute fact. It justifies a statement and proves an incident or occurrence. Unless, something is justified, people cannot believe the things or situation or incident. In our society, both literate and illiterate people discuss certain unjustified aspects. Few of them are quoted below.

1. Diabetes is caused due to intake of sugar or carbohydrate food substances.
2. Worms came to the body by taking of sugar, molasses and other sweet products.
3. Killing of frogs from our environment causes deafness in the person who kills them.
4. Catching of dragon flies leads to the death of the mother.
5. House lizards are poisonous.
6. *Varanus* are poisonous and if thay bite, the person would only be cured after lightning and thunder for seven times.

7. All snakes are poisonous.
8. Some snakes can run 2 ½ fields and kill the person by following the person.
9. Snakes do remember and attack the person(s) who attack them.
10. Precious stones are found in the head of snakes.
11 Tamarind tree in the vicinity of human habitat creates skin diseases especially leprosy.
12. Owls are bad omen.
13. Ghosts produce light in crematorium.
14. Success or failure depends on luck.
15 Specific situation or dress or symbols are auspicious.
16. Black colour is bad and red is good.
17. Specific numbers are better and lucky in the life which is the belief of some cricketers, scientists and students.
18.Twins are born because of intake of twin fruits or vegetables.

Iv. Process Of Communication

To overcome the misconception from the mind of the people of our society, some form of scientific communication is essential. The style of scientific presentation or the article or script is very important. The following steps must be taken into consideration while preparing a manuscript for the readers.

1. Before starting the article, the target group or age group of the reader must be taken into account. The writer should try to come to the level of that target group and accordingly script should be developed.
2. The article should have an attractive title to draw the attention and attitude of people.
3. The fact may be communicated in print media or electronic media. The matter to be communicated needs to be 3S, i.e.,

i) Short,
ii) Simple and
iii)Sweet.

To increase the palatability of readers, certain examples may be cited.

4. The language of the script needs to be in the form of dialogue between two friends or conversation amongst family members. Hard or difficult words or sentences must be avoided completely.
5. The explanation of the script needs to be substantiated by figure, diagram, chart and table with explanation. This adds clarity to the description of the article.
6. All the tables, figures etc should be numbered both in the diagrams and texts.
7. The description should be undertaken within 3 or 4 paragraphs in a page not in a large paragraph.
8. Spelling of the words in any language must be very accurate. That means article should follow ABC, i.e.,

A- Accurate,
B- Brief and
C- Clear.

9. The concluding line or paragraph of the article should be left with the summary of the theme or the important message of the article.
10. The overall article from the beginning to end must have coherence, so that readers can enjoy the reading and learning. That means reader should have 3R feeling namely, R- Read,
 R- Recall and
 R- Reuse.

V. Effect Of Science Communication

The development of the individual develops an educated family. The developed family develops a progressive society and the developed society ultimately develops a better country. The more the education, the more developed is the country. Because of unscientific approach, the progress gets inhibited or obstructed. Hence, the advantages of popular science communication are multifarious which are listed below.

1. Various cross sections of people get a chance to know about certain things.
2. The wrong conception or idea gets clarified.
3. People develop systematic method for day to day management and life style.
4. Farmers, rearers and breeders apply scientific application for better productivity and yield.
5. Awareness creates consciousness in the mind of the people of the society.
6. Scientific awareness generates an open mind with broad spirit.
7. People make themselves better in language and reasoning as well as logic.
8. Small message through popular science communication spreads like lightning to the common people.
9. School going children or college students, after reading scientific information can create or generate some other better scientific invention or innovation.
10. Science communication in magazine discusses all branches of science and people can gather and gain different aspects of different branches from a single copy.

Hence an attempt in popularization of science in all places like states and countries is highly desirable to educate both the educated and uneducated. So that the scientific message would reach the unreached which is the ultimate goal of the popularization of science.

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SCIENCE AND TECHNOLOGY-VEHICLES OF PROGESS..

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The dictionary defines science as systematic and organized study of a branch of knowledge. It aims towards understanding something unknown. Technology is the systematic knowledge and action usually of industrial process but applicable to any recurrent activity. When both joined together, they become the part of the development process that is inherent to civilization. Further both are regarded as the basic factors in the dividing wall between poverty and prosperity.

There is no doubt that science and technology have shaped and reshaped India over the years. The result of research and experimentation is seen in the transformation of a subsistence agriculture into commercial agriculture , eradication of diseases, establishment and rapid development of an industrial base, development of electronics, nuclear energy capability, space exploration, oceanography etc. all aimed to meet socio-economic needs. A review from the past to the present days on science and technology mission has been assessed to justify how it has become the vehicle of progress in India.

The vedic age marked a new era of intellectual inquiry and technological endeavour. Ancient mathematical works , astronomy, herbal medicines, process of dyeing, production of paper, perfume, sugar, use of new minerals (Ore and alloys), navigation (use of magnetic needle floating on water) are some of the major fields where the touch of science & technological minds associated.

However it was with colonization of India by England that new phase in science & technology progress began. But the educational and research developments during that period were directed to meet the British Government needs and not primarily meant for Indian socio economic betterment.

Only during 1784, the foundation of 'Royal Asiatic Society' (founder Sir William Jones) marked the beginning of public interest in scientific research. The society helped the founding of Indian museum (1866) and publication of research papers on physics , chemistry , geology and medical sciences in 1876, The Indian association of cultivation of science (founder Dr. Mahendra Lal Sirkar) provided laboratory facilities and became the prominent scientific research centre in the country. Later on during 1914, the formation of Indian science congress association took initiative and played a major role in creating a broad scientific consciousness bringing scientists together & enabling them to make the government give support to scientific research.

In 1942, an Industrial research fund was created by the government for the purpose of fostering industrial development in the country & CSIR (council of scientific & Industrial research) was constituted to administer the fund. The proposals for the establishment of National physical laboratory, National chemical laboratory, other Laboratories for food technology, building, road, leather , electro-chemicals etc. were formulated. After independence such institutes at national level and many other research institutes at regional levels were also established.

It is worth mentioning that before independence a few institutes were also set up by scientists or public men. To name a few, those were Indian Institute Science , Bangalore (1911). The Bose Institute Kolkata (1917), the Indian Academy of Science, Bangalore (1934) of which the Raman Research Institute is a part, Sheila-Dhar Institute of Social Science, Allahabad (1936), the Tata Institute of Fundamental Research, Mumbai (1945), Sri Ram Institute for Industrial Research, Mumbai (1947). Their developments were accelerated only after independence & they are now centre's of higher studies & research in their respective fields.

Post independence scenario

Pandit Jawaharlal Nehru India's first prime minister was fully cognizant of the indispensability of science & technology in the economic & social development of the country. In fact he moved in parliament the scientific policy resolution during the year1958.

The main aim of the policy was to foster, promote & sustain the cultivation of science and scientific research in the country & to encourage individual initiation for disseminating of scientific knowledge, to recognize the work of research scientists and ensure that the creative talent of men & women is nurtured to find full scope in scientific activity. Simultaneously during 1983 after the constitution of an autonomous Technology Information Forecasting & Assessment Council (TIFAC) & its subsequent report on the technology policy-statement came into effect with a view to

attain technological competence & self reliance, maximum development with minimum capital conservation etc. During that time technology forecasting and assessment studies were undertaken for petrochemicals, Housing, Building technology and skills, Human settlement planning, Technology modernization of steel plants sugar, fertilizer energy (coal combustion) Electronic material etc.

Through a series of meetings & conferences, science programme formulation in India was started to develop its own model of R & D planning . The scheme was designed for operation in two steps for effective participation of the scientific community in decision making.

Step-I : Formulation of broad policy guidelines from the Planning Commission on thrust areas.

Step-II : Ensuring interaction with scientists at National and Regional Laboratories including Universities for proper execution.

In the light of such visualizations, five year plans were adopted in India with clear objectives from the year 1951. In that year, the 1st Five Year Plan started with clear-cut developmental activity for implementation . It was seen that from that plan period to the 5th Five Year Plan (1951-1980) , setting up. of National Laboratories, research institutes for translating results of scientific research into commercial production, training of personnel for research institutes & for running industrial needs, linkage between research & industrial needs, manufacturing scientific & industrial instruments, research in crop disease control, dry farming, preparation of agricultural implements, survey and research on natural resources, space programmes, electronics were progressed to a great extent to cater to the need of our county.

During 6th plan (1980-85) it was felt that the task of creating scientific temper is of vital necessity for the growth of science and its utilization in the developmental process. Hence a close nexus between science, technology and education was envisaged. The plan also aimed at creating new research areas on plasma physics, immunology, applied microbiology as well as creating necessary back ground to transfer the benefits of science & technology to rural areas . In subsequent plan periods, emphasis was given on food production as well as new thrust areas like robotics, biotechnology, micro electronics, materials science, modern biology, oceanography for further promotion of the country's development. Simultaneously an approach paper (technology statement) called vision 2020 was prepared by department of science & technology (DST) in collaboration with the Confederation of Indian Industry (CII) to conduct further research in areas like agro food processing, waterways, road transportation, electric power, telecommunication, aviation, sensors , intellectual property rights and future technology forecasting, natural resource management, conservation of ecosystem, environmental pollution, global warming, conservation of wild life etc.

Besides all such progressive measures many societal programmes were also planned for execution. Science & technology for women, science & technology application for weaker sections, science and technology application for rural development, Tribal sub plan programmes, population control, rural satiation computerization of rural labourers were some of the major areas which are worth mentioning.

Basing on such thrust areas, our country is marching ahead for all round development due to the advancement of science and technology. The activities of Council of Scientific and Industrial Research (CSIR) which started functioning since 1942, are directed towards the same.

A list of network of CSIR are indicated below where researches are going on towards effective utilization of India's resources development of new products, processes and technologies to strengthen Science and Technology base in the country and to improve the quality of life of our people.

CSIR Network

PHYSICAL & EARTH SCIENCE.

- National physical laboratory, New Delhi.
- National Geophysical research Institute. Hydrerabad.
- National institute of oceanography, Goa
- Central Scientific Instruments Organisation Chandigarh.

CHEMICAL SCIENCES

- National Chemical Laboratory , Pune
- Central Salt and Marine Chemical Research Institute Bhavnagar.
- Central electrochemical Research Institute, Karaikudi.
- Central Leather Research Institute, Madras.
- Central Fuel Research Institute, Dhanbad.
- Indian Institute of chemical Technology, (RRL) Hyderabad,
- Indian Institute of Petroleum, Dehradun.
- Regional Research Laboratory, Jorhat.

BIOLOGICAL SCIECNES

- Central Food Technological Research Institute, Mysore central Drug Research Institute, Lucknow.

- Central Drug Research institute, Lucknow.
- National Botanical Research Institute, Lucknow.
- Indian Institute of Chemical Biology, Calcutta
- Institute of Microbial Technology Chandigarh.
- Central Institute of Medicinal & Aromatic Plants lucknow.
- CSIR Complex, Palampur.
- CSIR Centre for Biochemical's Delhi.
- Centre for cellular and Molecular Biology, Hyderabad.
- Industrial Toxicology Research Centre. Luck now.
- Regional Research Laboratory, Jammu.

ENGINEERING

- Central Building Research Institute Roorkee.
- Central Electronics Engineering Research Institute pilani.
- Central Road Research institute, New Delhi.
- Central Mining Research Station Dhanbad.
- National Metallurgical Laboratory, Jamshedpur.
- Central Mechanical Engineering Research Institute Durgapur.
- Structural Engineering Research centre Madras.
- Structural Engineering Research Centre , Ghaziabad.
- National Environment Engineering Research Institute, Nagpur.
- National Aeronautical Laboratory, Bangalore.
- Central Glass and Ceramic Research Institute, Calcutta.
- Regional Research Laboratory , Bhopal
- Regional Research Laboratory, Trivandrum.

INDUSTRIAL RESEARCH ASSOCIATIONS.

- Electrical Research and Development Association Vadodara.
- Toklai Experimental Station , Tea Research Association, Jorhat.

INFORMATION SCIENCE.

- Indian National Scientific Documentation Centre New Delhi.
- National Institute of Science, Technology and Development Studies New Delhi.
- Publication & Information Directorate, New Delhi.

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OZONE DEPLETION, A HARBINGER OF HEALTH HAZARDS

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What is Ozone: -

The element oxygen exists naturally in two forms. The more abundant form has two atoms of oxygen joined together to form a molecule. This is the oxygen we breathe. Sunlight keeps breaking the O_2 molecule into two oxygen atoms. These atoms can rejoin to form oxygen or join another oxygen molecule and make O_3 or Ozone. Almost 90% of Ozone in the atmosphere is concentrated in the stratosphere - the layer of the atmosphere between about 10 and 50 km altitude. It acts like Sunscreen lotion and absorbs a large proportion of the Sun's ultraviolet (UV) radiation which would otherwise sterilize earth and eliminate life from the planet. It absorbs the most energetic UV-c and UV-b radiation and filters about half of the UV-a radiation. Exposure to these can cause sunburn, lead to Cancer and damage eyes.

Why is it getting depleted?

There are many naturally occurring substances that can destroy ozone. For instance, ozone gets destroyed when it comes in contact with molecules that contain nitrogen, hydrogen, chlorine, bromine and so on. In the atmosphere, oxygen and ozone molecules are continuously converting into each other and a balance is maintained. But of increasing man made pollution and the release of gases like CFCs (chlorofluorocarbons) the natural balance is broken and the amount of ozone destroyed is far higher than the amount naturally formed.

What is the ozone hole?

There is nothing like a continuous layer of ozone in the atmosphere and a hole in that coating. Ozone does not form any layer. It is dispersed in the atmosphere like other gases. But the zone of atmosphere where ozone has maximum density is called the ozone layer. The density of ozone is measured by Dobson units. The average amount of ozone in the atmosphere is about 300 Dobson units. If all this ozone is compressed at zero degree Celsius at one atmospheric pressure it would form a 3 mm thick layer around the earth. What we call ozone holes are the areas where the concentration drops to an average of about 100 Dobson units. 100 chemicals are being phased out for ozone.

Initiatives to check the depletion:

A 1986 NASA study found the depletion of ozone over Antarctica. Human pollution results in ozone depletion It was also established that CFCs (chlorofluoro carbons) were the main catalyst in ozone's destruction. The first measure global initiative to restrict CFCs was taken when the Montreal Protocol was signed in 1987. The protocol requires the control of nearly 100 chemicals.

For instance, hydro chlorofluorocarbons (HCFCs) are to be phased out by 2030 in the developed world and 2040 in the developing world. By these initiatives the depletion which had stretched up to an area of 26 million square km in 1998 was reduced to 22 million square km in 2009. The presence of harmful chemicals around the clouds accelerates the degradation of ozone. West polluted and we are paying. The developed countries that have overused the atmospheric carbon sink help developing nations build infrastructure for alternate sources of fuel that do not result in carbon emissions.

Health hazards:-

The Sun can nourish or destroy our body by UV radiation. The sun's ultraviolet rays are torpedoed down to earth. The UVC rays are blocked by the atmosphere, so they have little effect on us. The rays that are constantly being played into our body are the UVA rays and the UVB rays. If the UVB rays are stopped at the level of the skin, they can still cause burning and cancer of the skin and tanning as well. Moreover, if the UVA rays penetrate deep in to the skin they cause burns, wrinkles, and skin cancer. To top it up, sunlight also destroys the reserves of folic acid, also known as folate or vitamin B9. Folate is needed; so our body can replicate DNA properly (that is why it helps protect against birth defects). Also the rays can damage our eyes.

How do UV rays cause damage?

One of the ways that the rays cause damage is through the connective tissue breakdown. UV radiation causes the structural protein of our skin, collagen to break down and disable our ability to repair damage. Another way the sun ages our skin is through the formation of free radicals- those aggressive charged compounds that damage cells break

down collagen as well. Free radicals can cause cancer by changing our DNA and preventing our body from repairing it. How? UV destroys the rungs of the DNA ladder so that the DNA ladder posts bind with one another. This makes a bulge so that the DNA does not form or function correctly. Still another way that the UV rays cause damage is by thinning the walls of surface of blood vessels, leading to bruising, bleeding, and showing the appearance of blood vessels through the skin. The Major Ager of UV radiation has a great impact on our eyes by oxidizing the pigments in the retina and decreasing the antioxidants in the thin, yellowish film that protects it: meaning that these delicate cells are always at the risk of being damaged through another Major Ager, free radicals. Sunlight damage to the eye is cumulative-particularly in conditions like macular degeneration, where the cells die from oxidative damage. Radiation from the Sun that passes through the ozone stimulates our eyes (Visible rays) and our skin (UV rays). The UV wavelengths either bounce off the dermis or penetrate deeply into our tissues like the depletion of folate.

Protection against Ultra Violet Radiation:

The Environmental Protection Agency (EPA) has cautioned people to protect themselves against UV light 'whenever you can see your shadow'[1]. Some of the common preventive measures that need to be followed are to avoid overexposure to sunlight especially between 10 am to 4 pm when the UV rays are at their strongest. It is advisable to make sure to be adequately protected by wearing the appropriate clothing and protective covering like hats whenever exposed to the sun. Make sure to carry an umbrella when going out. One must ensure to apply a generous coating of appropriate sunscreen suitable for the skin type after consulting a dermatologist. Sunscreen Lotions are available in different SPFs like 15, 30, etc. One should always avoid artificial means of tanning, such as the use of sun-tan beds. In case of blisters due to overexposure, the neighborhood GP or dermatologist should be consulted for right diagnosis and treatment so that the condition does not worsen.

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POPULARIZATION OF SCIENCE AND OUR COMMON FUTURE

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Man, since his origin, has lived in harmony with nature through the ages, holding nature in awe and reverence. The Vedas, folklore and scriptures of different religions, faiths and beliefs also speak of the need for harmony with the universe, which is the habitat not only of man but also of all animals, birds, insects, plants and vegetation. The mutually supportive role of all living things is often mentioned as crucial factor for a balanced social and harmonious existence.

After United Nations Conference and Environment at Stockholm in 1972, "Conserve or Perish" has become the slogan of mankind all over the world. During the first part of 21st Century the greatest question which concerns human being is the ever increasing human greed and aspirations in view of the alarming growing population and the shrinking means of subsistence. Man is at the brink of ecological disaster, the measures for environmental protection have to be taken only today or tomorrow may never come. Hence, the importance of environment education relevant to our country for preservation of life on earth cannot be underestimated.

"Earth provides enough to satisfy everyman's need but not everyman's greet"
- Goutam Budha

If industrial civilization and its value system and life style have consumed the natural resources and polluted the environment, should we not question the kind of industrialization that has emerged in the West and the kind of values that sustain such development to pursue truth ?

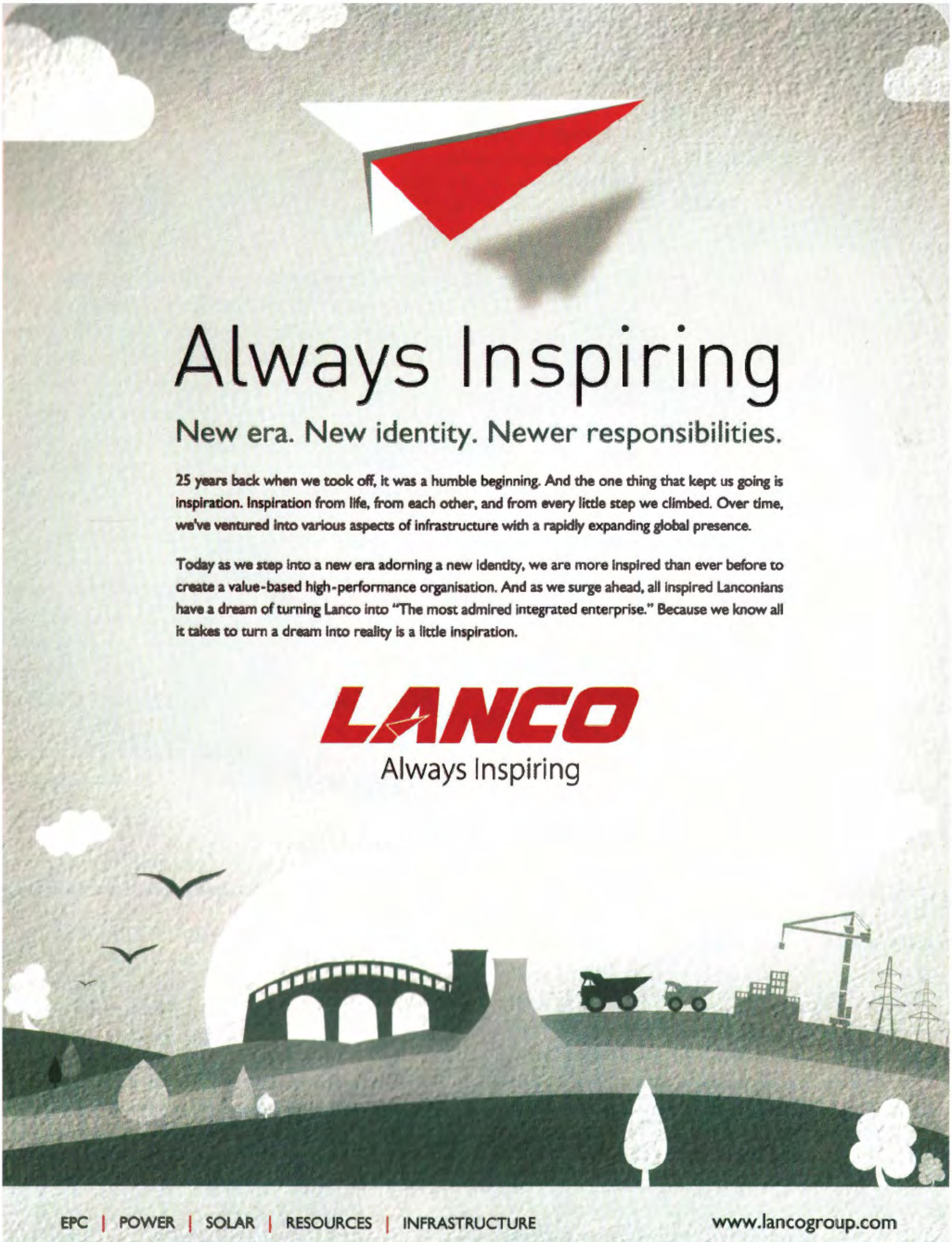
Science has changed the entire life-style of the human beings and their beheaviour towards nature. There is no two opinions that the 'planet is dying'; man has become the butcher of the nature. Man is coming across so many horrifying environmental disasters like global warming, depletion of ozone layer, increase of CO_2 in the atmosphere, but unmindful about the events accelerating the process of degradation.

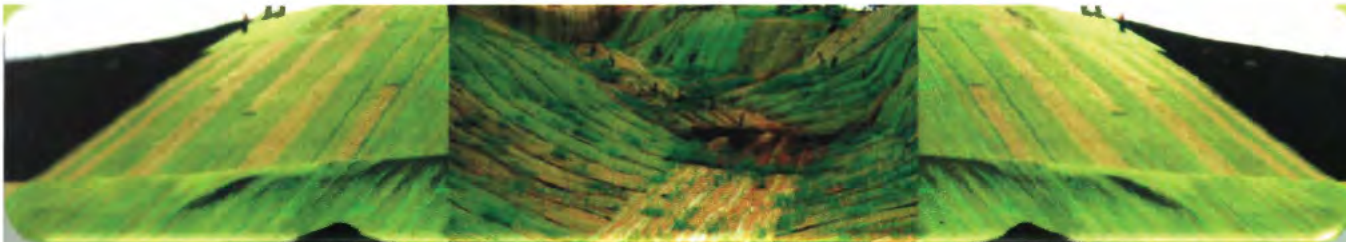
Popularization of Science is an attempt to reduce the distance between Science and everyday knowledge. For narrowing that distance, it is necessary to build a new special discourse, in which scientific knowledge is subjugated to a process of transformation to the audience's way of understanding. The different programmes undertaken by the Government for popularization of Science are 'Vigyan-rail', TV and radio programme. Its publication and information system, have been of huge success in terms of improving people's understanding of Science. In its electronic form it has increased the accessibility, visibility and popularity of Science and scientific research.

Science curriculum should be developed and updated from primary to degree level in order to be informative, broad-based, knowledgeable to traverse the truth. The International Year of Forests, 2011, is a global platform to celebrate people's action to sustainably manage the forests of the world.

To inculcate the scientific temper environment fairs for school children Science awareness camps and Science exposure trips should be organized for the people. This will popularize and communicate Science among people at the grassroot level and provide exposure to school children to the latest scientific developments. Science popularization will reduce the distance between Science specialists and the public and improve the understanding of Science.

We need to blend the experimental knowledge of the past with the scientific knowledge of the present, not to create a new knowledge but also a new wisdom. The task is difficult but we have to revive the long lost harmonious relationship between 'Man and Nature'.

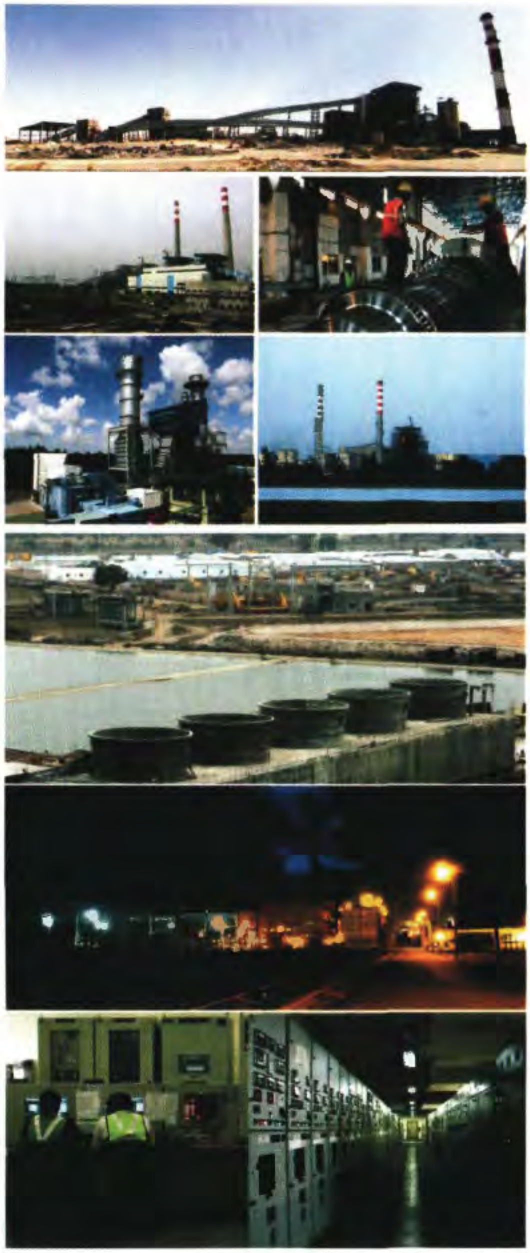

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POPULARIZATION OF SCIENCE IN ODISHA

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In this twenty first century, Science is permeating to every quarter of human civilization. Life cannot proceed a step without the help of science. From birth to death at every moment it facilitates us like a friend of our own. The basic needs of human beings such as food, cloth, shelter, health, education, life security almost all aspects of life have been influenced a lot by science, to serve the best to the society. Science makes a man perfect in many aspects.

Science is nothing but a search through experiment not only in the physical world, but also in the logic, behaviour and so on. The virtue of truly scientific mind is the readiness to reject, what is false or untrue. Therefore, it is necessary to think how to spread the message of science to the people down the line and how to popularize science among people at every level.

Keeping these views in mind, science has been taken as a core subject of the curriculum in the educational system of almost all countries. The policy makers of education have thought a lot to make science popular through the curriculum design of their own country. Because, if a child is trained from his childhood with the knowledge of science and its gifts for human civilization, then he may be able to make science human friendly and can use it for constructive purposes only. And if a child is aware of the goodness of science, then the message may easily spread in his family and in his surrounding also. Hence, educational system and curriculum play a vital role to popularise science among society.

The human community, which is the real user of the noble gift of science, must be aware of it. The knowledge of science should also reach the heart and soul of a layman to obtain its fragrance from every angle. Therefore, it is highly essential to popularize science in every nook and corner of the society.

Many ways may be adopted to make the science popular in human society. But, it is a point to be thought that, how much better is the way to achieve the goal.

There is no doubt about the role of media to popularize science to a great extent. It may be the electronic media or print media; they are doing a lot to popularise science through their episodes, talks and pages with several activities and articles. Television channels like, 'Discovery,' 'National Geographic', Doordarshan and many others telecast so many programmes.

Going one step ahead, the internet now a days plays as a leader to popularize the science. One can gain a lot of knowledge from internet, by using different websites and wikipedias. Complex topics can be easily understood by animation world of pictures and science literatures, written by different eminent writers. "Pen is mighter than sword" has been proved also in popularizing science for human community. So also "seen is mighter than listened", has been proved through audio-visual assistance of electronic medias.

Science may be popularized in different manners through creativity. Dramatization picturisation, documentary edition of scientific awareness programme, science related issues have a great impact to make the community closer to the science, by explaining it in a simpler form. Many times roadside drama on different science related topics like health hazards, awareness etc. are able to touch the hearts of the villagers of remote areas, who are devoid of education. Such activities and creations help to popularize science as a stronger medium.

Different Government Agencies and Non-Government organizations are also taking the leadership in popularizing science in the states and country.

Department of Science and Technology, National Council of Science Technology and Communication, National Council of Science Museums, National and Regional Science Centres are such giant Government Agencies which, through their variety of activities are able to attract thousands of people to know the science from near. By organizing different programmes at different areas of the country they extend the publicity for science. In Orissa, Regional Science Centres of Bhubaneswar and Dhenkanal are playing a vital role by exhibiting different science models, based on many current issues through mobile science vans in remote areas. They also try to get the people informed on the issues and become aware of that by organizing other popular activities adjacent to mobile science van exhibition.

Similarly, 'Bigyan Diganta' is a very popular monthly journal, published by Department of Science and Technology

which contributed a lot to popularize science in Orissa by publishing different science related topics in it. Thousands of persons including students, who are the habitual readers of it, get a lot of knowledge about many things. Like this, some other science journals which have established their repute in Orissa in this field are 'Science Reporter', 'Bigyan Aloka', 'Bigyan Mela', 'Bigyan Prava', 'Aneweshen' etc. Many books like 'Tell me why', Science and Invention', 'know your science', 'biography of scientists' etc. have also their own contribution in popularising science through their articles assembled inside.

In the other hand it can be said that, the movement to popularize science in Orissa has become accelerated due to the role of Bigyan Diganta and Department of Science and Technology.

Besides this, some organization like, Srujanika, Janapriya Bigyan Mancha, Bigyan Prachar Samiti, National Science Congress etc. are doing a lot of work to popularize science in Orissa, by involving people in different activities organized by them, through out the year.

In this context, the role of School and Mass Education Department of Government of Orissa also is not far behind. Under a special scheme "Popularization and Improvement of Science Education" the Department releases fund of Rs.50.00 lakhs to organize different activities, through Directorate of TE and SCERT (Teacher Education and State Council of Educational Research and Training) which also acts as the State Academic Authority of Orissa State. The Department of Science and Mathematics is in-charge of doing such activities to popularize science among the school children and community and to improve science education among the schools under the direction of the Director, TE and SCERT. Among their activities there are students' Science Seminar, Science Exhibition, Science Drama, Science Olympiads, Science Quiz, Science Model Making, assisting in publication of science magazines at district level, science club activities, to popularize science and organizing different workshops and orientation training to teachers and students to improve Science Education throughout the year to extend the support to the community. Celebration of Science Day at district level and State level are a part of the activities. Activities like science is fun, "science in every day life", "curriculum based teaching aids preparation" are very much popular programmes. Science exhibition which are organized at school, block, district and state level have a great impact on nearby community. Thousands of visitors, come and visit the exhibition where hundreds of projects and models are exhibited connecting with different fields of human life, such as food and agriculture, communication, health, environment and pollution control, disaster management, sports and culture etc. Several numbers of projects based on the above themes are appreciated by the visitors and others who desire to adopt the techniques in their practical use. Since last year, Government of India has also started a scheme named 'INSPIRE' to facilitate with monetary benefits the good science projects made by the students from class VI to class X.

Similarly, other Departments like Energy Department, Health Department of Government of Orissa also have made their own ways to popularize science in their respective fields by spreading message of energy conservation, population education, different life skills, prevention and precautionary measures for different health hazards among the people. Now a days, there is explosion of knowledge through different sources, which brings the movement to popularize science to a peak level.

After all, a scientific mind or an explorative attitude is required to receive the message of science, generated through popularization. The agencies which are working to popularize science in different ways and in different areas, must be ready to transfer the required essence of it to that extent as is desired. Because science is a vast area full of secrets, standing at its door step only, shall not suffice to achieve the goal. So popularization of science must lead to open the lock of the science that is suppressed under the blind belief and superstitions. Since long especially in remote village areas where these are dominating the human behaviour must be altered through impressive ways, so that science can take a place in core of the heart of the villagers who are the real stakeholders of this effort.

Science is incorporated in ourselves; we can not alive without science. There are still many areas, to cover and to bring up the community nearer and closer to science. Many things are yet to be unfolded by the key of science knowledge. With the passing of time new inventions in technology may develop which may help to popularize science in some other easier ways, so that people will seem to eat science, sleep science and dream science only to make their lives much better than to day. Let us hope for the best and wait for the coming tomorrow to see science as such a part of human society.

■ ■

Role of Youth in Popularization of Science

THE CONCEPT OF SCIENTIFIC TEMPER

Sri Nihar Ranjan Acharya,
Founder & Director, TRUST

"A science in its development is i) A collection of exactly observed facts; ii) A correlation or generalization of these facts, forming a system; iii) A formulation of these generalizations as laws; iv) It proceeds to some principle or force accounting for these laws; hence, exact knowledge of proximate causes." (Condensed from 'The Standard Dictionary')

"Science is Knowledge reduced to law and embodied in system." "Knowledge of a single fact, not known as related to any other, or of many facts, not known as having any mutual relations or as comprehended under any general law, does not reach the meaning of science."

Science depends on actual observations and the conclusions drawn from these observations which may change from time to time depending on the accuracy of the observations obtained by newly developed instruments, methods or ideas developed in related areas. The most prominent example of such observation is the 'Theory of Gravitation' observed by Sir Isaac Newton who saw an apple falling from an apple tree – many of us would have been content by picking up the apple and judging its quality by eating it. Newton on the other hand started thinking over it. Why did it fall? How did it fall? Why did it go to some distance? So on and so forth.

Great thinkers and observers starting from Archimedes and great scientists like Galileo did not accept facts as obviously presented without going to their core. Those who are great scientists do not rest satisfied with the existing ideas. They believe that further development of science will bring out more changes. People should be willing to modify their views in the light of new observations.

Relations of Science and Art: Art and Science are inseparably bound together. Every art has its foundation in science, and every science finds its expression in art. Consciously or unconsciously the artist or the craftsman at work is applying principles and laws, formulated and systematized knowledge of which constitutes science.

Science and Scientific Temper: Thus science is a constant exploration of the reality of nature in an attempt to realize the truth. In simple words, every phenomenon, be it natural or social is law governed or process governed; and to understand it is nothing but science. Our curiosity to understand nature by making such observations that demonstrate our thirst for knowledge is, in fact the stepping-stone for developing a scientific temper. Having scientific temper or scientific frame of mind means that one has the disposition to question the existing facts and critically challenge the 'given ness' of any a ~ priori knowledge. No doubt then, with true scientific spirit, one can constructively respond to the challenges of the world. A scientific temper is observant and asks questions as to why things in nature exist the way they are; like why sky is blue or the grass is green, why setting sun looks red! Science Education is very much essential for school children, whether to 'understand their own health and hygiene' or to 'understand the phenomenon of the vast universe. A scientific temper is necessary to provide us with the ability to modify our environment to our advantage. We need it to find solutions to the problems of everyday human affairs. In Science, right to question is fundamental. Science progresses because people exercise their right to question.

Scientific Temper vs. Superstitions: One, who believes in logics, does not believe in superstition. Superstition involves beliefs, practices and procedures based upon conscious or unconscious assumptions usually concerned with the nature of cause and effect; whereas scientific temper signifies an open mind and the liberty to question. The Oxford Dictionary defines Superstition, as a thoughtless fear of something unknown or mysterious especially in connection with religious belief based on fear or ignorance. Superstitions, belief in astrology, witchcraft and sorcery and health related misconceptions are very detrimental to the society. Consulting astrologers to begin any work is yet another phobia tinsel people suffer from.

Further in answering to the question - why are we superstitious? It can be said this much that we are conservative and hold very tightly the old ideas and customs long after their original purpose has been lost or forgotten. The cycle of formulation, prediction and falsification (or proof) is the core of the human scientific activity. Alleged connections that cannot be captured in these nets of reasoning are out either as hypothetical or as false. Science is based on facts and is not driven by emotions. Hence, today's youth should be encouraged towards critical thinking and

given freedom to question and explore. There is a need to raise debate between reason and belief to establish the credibility of science against the speculative worth of superstition.

Miracle: According to Chambers Dictionary meaning of 'miracle' is that it is a supernatural event or a wonder or a marvel. But modern science has convincingly established that there is no possibility of any supernatural events in this vast and otherwise varied universe. Whatever happens here, it proves, is natural and has natural explanations. Hence, a miracle can be defined as an event or an occurrence beyond the level of being objectively understood or deciphered by an individual or a group of individuals, at a given time or situation. From the above definition, it follows that occurrence of a miracle depends upon an individual or a group of individuals who experiences the miracle. It presupposes that the basic attributes of a miracle revolve around the cerebral attitude and environmental conditions of the perceiver of the miracle.

No miracle, irrespective of its hue or color, is an exception to this truth that people have the tendency to accept sometimes the very ordinary occurrence to supernatural happening i.e., one's extraordinary fascinations of a deranged mental condition.

Cognitive Disorders: In terms of miracle, we are essentially confronted with two major categories of cognitive disorders, popularly known as illusions and hallucinations.

Illusions: It is defined as a distorted or false perception of an existing thing or matter. e.g., it is a usual occurrence on summer sunny days, for high way drivers to see layers of shinning water in front of them, right in the middle of the road, extending for miles and miles. Now, a question arises in our mind that why, after all illusions occur and in what circumstances! They take place, either in a healthy person or in a mentally sick person, when the cerebral hemispheres and its working are obliterated or reduced. At that time, the cells in the cortex are completely or partially in a hypnotic phase.

Hallucinations: These are entirely imaginary or fabricated perceptions. Their main peculiarity is the complete absence of any real objects of perception or real stimulation of sense organs. Nevertheless, these false perceptions appear to be real and to have external projection. The imaginary objects perceived, occupy the same position in space as real objects and finally are so apparent to the perceiver that he relishes no doubts about the authenticity and reality of what he sees, hears or experiences. It results from mental derangement. They can be of elementary nature or they can be very complex in intensity. However, elementary hallucinations are less serious as compared to complex ones. Seeing sparks of light, hearing crackling sounds etc. are elementary hallucinations. These experiences normally take place even while the perceiver is in total wakeful state. Complex hallucinations are of serious nature, they are of things and scenes of events. They also may occur in apparently wakeful state. The most common classifications of hallucination are by auditory, visual, olfactory and gustatory sensory organs. The sufferer or the perceiver of hallucinations believes of having heard a voice commanding him to do something or not to do it. It occurs when the cerebral cortex is in a transitory state of hypnotic phase, when the cells in the cerebral hemispheres pass from the state of wakefulness to partial or total inhibition setting over the central nervous system.

Delusions: These are false opinions and beliefs, born of morbidity, which does not correspond, with the true position of things. They always have morbid basis and are distorted, perverted reflection of objective reality.

Hypnosis: It is a state resembling normal natural sleep in which the subject or the person who is hypnotized is responsive to the suggestions made by the hypnotizer or the hypnotist. Thus hypnosis, the artificially created inhibition concentrated on certain particular cerebral centers, is governed by a conditioned reflex while natural sleep is the result of string-pulls stage managed by unconditioned reflexes!

We are proud of our country where blind beliefs and superstitions rule instead of science. In a country where the majorities are illiterates it would be logical to think that it is the load of ignorance that stands in the way of inculcating a scientific temper in this country. Few would suspect that it is the other way round; professed 'scientists' who are steeped in superstitions are the real stumbling block. The question naturally arises how a scientist can be superstitious because superstition and science should indeed be antonyms.

It's the season of miracles in the country. It all started with the waters of the sea in Mumbai turning sweet. The next we heard it was idols drinking milk and then a tree oozing water, and next the form of a renowned saint appears inside a cave. Then we heard of sacred water coming out from idols – it goes on and on, until one starts wondering whether India has suddenly turned into a hotspot or most favored destination for miracles, superstitions of all kinds and hues.

Scientific explanations are available for all such miraculous occurrences. But is the human mind ready to accept these explanations? Faith seems to overpower rationality every time there is a tussle between miracle and science. The human mind is often conditioned to accept

facts as they are told without enquiry. Moreover, with people facing situations of grief and sorrow, of pain and suffering, and of illnesses many of which are at present untreatable, they often turn to what would be regarded as supernatural or irrational, for some amelioration and relief. We have to educate people regarding the problems we are facing, the price we are paying for countless superstitions in our society.

The concept of scientific temper has to start from the kitchen. The mother has to stop teaching the child that if milk is getting burnt it's not a bad sign; rather it's an indication that a small negligence can cause a bigger loss.

Fundamental duties in Part IV A, the Article 51 (A) h of Indian Constitution states that "It shall be the duty of every citizen of India to develop scientific temper, humanism and the spirit of inquiry and reform."

Popularization of Science: A Need

Every act of our's and nature's has a scientific explanation. In India, people know a lot of things but do not know the scientific explanations behind them. For example, pickle makers add lots of salt to pickle making medium, but they themselves do not know why they do it. The simple reason that adding of excess salt makes the medium hypertonic and causes ex-osmosis in bacteria thereby ruining the pickles is not known to them or most people. Until and unless science is popularized fully, people will believe in superstitions. These superstitions destroy people. They contain no logic at all. Still so many people believe it. Popularization of science is a basic requirement for a country's development. It should go on and never be stopped.

Scientific knowledge here does not mean how much quantity of science facts are known to an individual, but it essentially includes thinking 'critically' and 'creatively' and in essence rejecting what is mere superstition and blind belief. In a way it is striving towards 'enlightened belief' and an open mind. Benefits of scientific and technological knowledge have reached almost every nook and corner of India, and have impacted everyone's life in one way or the other, but the requisite scientific awareness to think logically, rationally and objectively has not been created as yet. One can easily come across hundreds of examples in our daily lives where people worship articles of technology. Drivers can be seen touching engines reverentially but at the same time they may not mind driving after enjoying a few pegs of alcohol.

Superstitions are still rampant in our society. People are killed for witch craft, suspected witches are pelted to death, animal sacrifices, and even children are sacrificed. Health related issues like pulse polio drive, other vaccination drives, AIDS awareness, anti-tobacco campaign etc. are not getting the quantum of success they are expected to. Similar is the situation with natural resources conservation, environmental protection, cleanliness related issues etc. In all the above cases though there is no dearth of funds or government initiatives, the weakest link so far has been lack of mass awareness and public participation. Very recently, I saw a reputed news channel reporting fractures on the earth surface in same areas. They are common features formed by earth subsidence. Instead of going into the reasons, the channel showed the opinion of babas that started talking of pralay (doomsday) etc. Similarly, in another case I found an astrologer on a reputed TV channel showing the schematic diagram of the solar system, claiming that the traditional astrologers had prepared this and modern science has stolen it from there. We need a real aggressive campaign to popularize science and scientific temperament especially for a nation reeling under poverty and other survival related issues. In fact, such efforts need revamping and re-look so that these become a mass movement and cover the vast spectrum of our one billion plus population. I do not think that we have any other option except to accelerate these efforts.

The tragedy is that when 21st century demands a higher level of commitment to humanity, democracy, self-respect of the individual and the development of scientific temper, a large majority is allowed to be hoodwinked into superstitious, baseless and fake claims of super natural powers to cure, give solace and prevent bad things from happening in future! It is the time, 'Science Lovers' make their presence felt and expose the frauds and betrayers of the nation as they are weakening the very resolve of a nation to have self-respect, self-confidence and use scientific approach to create new things to march ahead. We have miles to go but the reason that everybody is endowed with 'must be helped attitude' to rise from the ashes of ignorance and make its presence of conscience felt.

In the year 1925, a teacher in Tennessee named John Scopes was tried and convicted for teaching Darwinism. It was considered unlawful to teach any doctrine opposing divine creation. Eighty years down the line, the debate continues to rage in some segments of society in the Western world. A major debate on "Intelligent Design Vs Evolutionary Science" kicks up a lot of dust in United States during the onward march of humanism in the year '05. However, a Pennsylvanian judge closed the debate with his proclamation that Intelligent Design is not a subject to be taught in Science classes.

When human beings dreamt of flying like the birds, they invented the airplane. And when they set their sights to outer

space and much beyond to the Moon, they came up with spacecraft that fulfilled their journey towards Chandamama (moon). Since long, scientists have also been looking at the Sun and dreaming of ways to replicate its energy-generating mechanism. Scientific evolution has conditioned human minds to seek some meaning and higher purpose in the vast expanse of the Universe. Since the dawn of civilization, science has gradually refined and advanced our understanding of the physical universe. No doubt, most of us are traditionally brought up on a diet of religion and rituals. But, it will be wise not to let our religious orthodoxy come in the way of scientific temper and progress. Some day in the distant future, there may be inventions that will be able to sense the Intelligent Designer and mankind may then be able to communicate with this Intelligent Designer and find an answer to the ticklish question – What happened before the Big-Bang?

Here, Hawkins's statements need to be addressed. Although it is not original with him, it is this: "we are such insignificant creatures on a minor planet of a very average star in the outer suburb of one of a hundred billion galaxies. So it is difficult to believe in a God (Intelligent Designer) that would care about us or even notice our existence." There isn't any evidence to date that life exists anywhere else in the universe.

Human beings, thus far, appear to be the most advanced species in the universe. To prove us positively is the need of the hour.

Science lovers are imbued with a scientific temper; question whatever does not appeal to reasons and, therefore, have a free mind. Love of science encourages openness and inquisitiveness. A questioning mind does not accept anything as infallible truth. Nothing is acceptable unless it passes tests, verification, comparison, analysis and further analysis. Dogmas and superstitions are anathema to a lover of science.

Knowledge is nobody's preserve, nor are the lines in the Vedas sacrosanct (i.e., that can not be violated or altered); even Veda (it is a Sanskrit word which means knowledge) teaches us "SA VIDYA YA VIMUKTAE" (That means i.e., knowledge which liberates us from ignorance). Yesterday's truth may turn out to be today's falsehood and today's unverifiable thesis may be a verified fact of tomorrow. Sometimes, some views may not be acceptable to some people for some reasons. A fact valid within one frame of reference may be invalid in another frame of reference. That is the relativism of knowledge. One who knows it, would not quarrel over differences of opinions nor kill another who does not subscribe to one's religious belief.

The Intelligent Designer, if at all it exists, we should dare to study its mind - if it is there, may have rested after the creation but mankind shall not rest and should continue the quest till an answer is achieved. That is what the purpose of Scientific Temper all about - that is what "The Concept of Scientific Temper" teaches us.

"Jai Bigyan, Jai Insaan"
(Victory to Science, Victory to Human-beings)

SCIENCE AND TECHNOLOGY LITERACY IN SCHOOLS : PRAGMATIC CONCERNS FOR SUSTAINABLE BASIC SCIENCE IN SCHOOLS IN INDIA

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INTRODUCTION:

Science has been man's greatest ally since the dawn of civilization. It has created innumerable pathways to progress that have taken man from his primitive cave habitat to the moon, indeed a very long journey in terms of both space and time. The scientific and technological breakthroughs, along with the changing attitudes of the Indian society towards scientific thinking, haveled to a change in every walk of life. However with passage of time the pace of Scientific innovation and research has witnessed declining trend as compared to global innovation and research index. This is reflected from the fact that since Sir C.V. Raman India has not carved its niche in the field of excellence in basic science and miserably failed to achieve noble prize . The research out put of our country is lagging far behind our neighbor China and European countries. Our science institutions like IITs and Central Universities are losing their place in global index.

SATE OF AFFIRS OF BASIC SCIENCE:

India Science Report 2005 reveals shocking picture of Indian science and Technogical growth.

- At the class VI to VII level, 22% of the students said they would like to study pure science at higher levels of education. Yet, when it came to students in class XI and XII, just 13.4% wanted to study pure science at the graduate/postgraduate level.
- Most of the teachers believe that more computers/equipment were required for teaching science subjects since inadequate practical training was a serious issue. While 15% felt that teachers too required proper training, 11% felt the need for simplification of the course content.
- India scores lower than the US on attitudes towards science and technology, but not much lower.

A comparative study of science literacy level of India and US endorse the rate of declining trend of S&T in our country viz.

Y/N Queries on scientific terms and concepts	India (2004)	USA (2001)
The centre of the earth is very hot	57	80
The oxygen we breathe comes from plants	86	87
Whether a new born is a boy or girl depends upon the father	38	65
Electrons are smaller than atoms	30	48
Antibiotics kill viruses as well as bacteria	8	51
The universe began with a huge explosion	34	33
The continent on which we live have been moving for million years	32	79
Human beings developed from an earlier species of animals	56	53
Cigarette smoking causes lung cancer	87	94
Which travels faster— light or sound	60	76
Does earth go round the sun or the sun round the earth	70	75
How long does earth takes to go round the sun	41	58

(Source: India: NCAER's National Science Survey–2004; U.S.A: Science and Engineering Indicators–2002.)

Seventy seven per cent Indians feel S&T makes our lives healthier and easier as compared to 86% for the US. Sixty one per cent feel technology makes work interesting as compared to 89% in the US.

Further our Education System is afflicted with several age old problems such as:

- Technology continues to profoundly affect the way we work, collaborate, communicate & succeed which has not been penetrated to all the strata's of academia involving science education.
- External Examinations 'are largely inappropriate for the knowledge society of the 21st century and its need for innovative problem solvers'.
- Limited Techniques of teaching & Evaluation do not identify learner's level of attainment.
- Class room teaching is highly dominated by the teacher.
- Technology integration is far away from content dissemination which causes poor learning attainment.
- Teachers are not skilled to handle various resources to make their subject interesting that causes frustration and humiliation among learners.
- Non availability of minimum infrastructural facility for technology integrated content dissemination by the teacher.

At this juncture Science literacy Technology(SLT) at school levels find immense importance.

RATIONALE OF SCIENCE LITERACY TECHNOLOGY (SLT):

In the context of SLT in science education, the goals of teaching and learning are largely directed towards engendering cultural and democratic notions of scientific literacy. It argue that in order to broaden students understanding of science, and better prepare them for active and responsible citizenship in the future, the scope of science education needs to go beyond learning about scientific theories, facts and technical skills. Therefore, the fundamental aim of SLT is to equip students to understand and situate scientific and technological developments in their cultural, environmental, economic, political and social contexts.

In essence, SLT aims to develop the following skills and perspectives i.e

Social responsibility

Critical thinking and self decision making skills

The ability to formulate sound ethical and moral decisions about issues arising from the impact of science on our daily lives.

Knowledge, skills and confidence, to express opinions and take responsible action to address real world issues in science and global challenges arised due to Liberalisation, Privatisation and Globalization.

Salient features of SLT



- ✳ Opportunities/ Challenges: Self discovery,new avenues of learning.
- ✳ Pedagogical approach: Constructivism and Experiential learning
- ✳ Knowledge/Understanding: It deals with interdisciplinary approach, Intra Integration of subjects like scince/geography/ History/philosophy/environmental sceince/ economics., Multiple perspective of self examination etc.
- ✳ Values and belief system:100% involvenent of teachers/students, Experimentation-observation-conclusion-hypothesis-thory module,self opinion making.

INNOVATIVE STRATEGIES OF SLT:

1.LEARNING SCIENCE WITH ANALOGIES:

Analogy, metaphor and over-generalization to maximize complex learning, and it's a skill that is taught in schools across the world. As per SLT analogies unveils another theory of Connectivisism. The only way to teach complex topics like statistics and database are by using analogies, building on the prerequisite conceptual framework classes such as "Algorithms" and "Data Structures" courses.

Some time Learning with Succedaneums makes good sense. The term "succedaneum" mean something that can be used in-place of another, and teaching by succedaneum is a critical skill for science and engineering courses. Poet William Wordsworth said it best:

The teacher starts with simple, over-general assertions, building layer-upon-layer of complexity on top of each generalization until the whole concept becomes complete.

Science appears as what in truth she is,
Not as our glory and our absolute boast,
But as a succedaneum, and a prop
To our infirmity.

William Wordsworth

Life is like a box of chocolates - The use of analogy in scientific instruction

Teaching by analogy and over-generalization is an integral part of the learning process, especially for complex concepts, and academic research confirms the centuries-old belief that children learn complex concepts best by analogy and over-simplification. For example, all junior High school kids like analogy jokes: "What does a oyster shucker with epilepsy have in common with a prostitute with diarrhea?" (Ans: An Oyster shucker shucks between fits) . Thus analogies are commonly used in science instruction -- for example, when an electrical circuit is compared to a water-flow system. Learners' models of a domain are shaped by such instructional analogies. Analogy is used to apply arguments used in examples to new problems, and similarity is used to extract principles from repeated, overlapping experiences.

2.GAMES FOR LEARNING SCIENCE:

Learning is more enjoyable during playing. Children learns better out side the classroom than inside the classroom. Hence science game sessions are as important as teaching sessions . Few short listed Games for SLT as listed below i.e

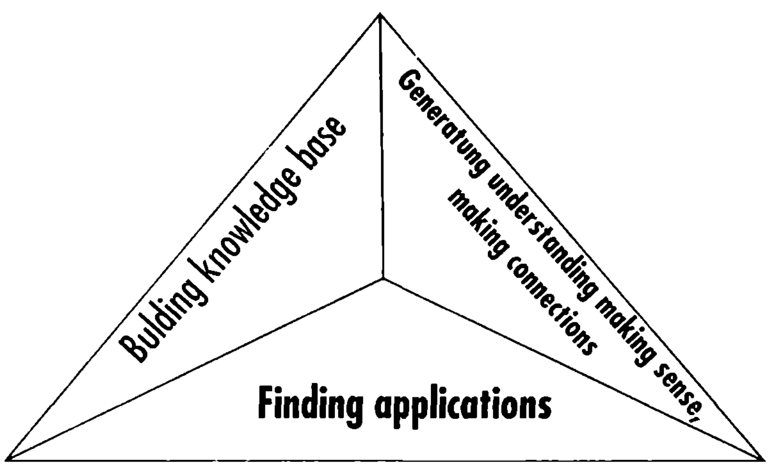
Game	Objective
Cell puzzle	: reconstruct a microscopic field of a plant tissue where the unitary pieces are the cells.
Creature game	: invent and construct creatures with the available pieces, group them and understand systematics and classification rules.
Schistosoma game	: associate pieces and verify your knowledge on parasitic cycles.
Energy metabolism game	:play with the biochemical pathways of cell energy metabolism
Human body puzzle	a puzzle developed to play with hospitalized children having cancer.
Inside the cell	: you are a scientist/detective and have to search inside different compartments of a cell the traces leading to construction of modern cell biology concepts
SPTZ metamorphosis	: three games to learn about spermiogenesis .
Seven error AIDS game	: a card game to introduce prevention concepts on AIDS

Other web sites for SLT games are :

PBSkids.org/games/science- an amazing selection of science games for toddler and preschool children. Similarly sciencekids.co.nz --- heaps of interactive online games & activities with subjects involving Living Things; Physical Processes; and Solids, Liquids & Gases. tki.org.nz/wickED/science -- Some wickED science games for kids about planet Earth, including earthquakes and volcanoes. BBC.co.uk/schools/science-- interactive science games for ages 4 - 11 years old LearningGamesForKids.com/preschool-- Fun interactive learning games for preschoolers in order to help concentration and recognition of colours & shapes. BBC.co.uk/CBeebies-- a multitude of excellent interactive games --- colourful, fun, with audio --- for toddlers and preschool kids. PlayKidsGames.com - a huge assortment of interactive alphabet games, vocabulary games, memory games, + geography & problem solving puzzles for preschool and primary school children

(PLANNING SCIENCE INSTRUCTION IN SCHOOL(HANDS ON APPROACH) Gone are those days where human brain was used for memorization. On the contrary due to ICT revolution the quantum of information is so high that human brain seems defunct to memorize. This has necessitated for development of other kind of skill (brain power) to cope with fast changing world of knowledge. Scientific creativity is one such power that 21st century human beings needs to develop not only for controlling nature but also to maintain human society & lead it to some higher plane than intellect could do. Every human being is endowed with this unique power (Science creativity) which may remain dormant in the absence of proper stimuli. Hence hands on experiments has wider role to expand the dimension of such a creative ability & curiosity of every learner inside the four walls of class rooms.

Further Mercedes model of teaching & learning lays grater emphasis on understanding application of Science knowledge more vividly. The key feature of the model is that it points up three aspects of teaching for understanding & application of knowledge: building a knowledge base, generating understanding & making a connection between new information & students ideas & finding applications viz.(Fig.1)



Other feature of the model is that it helps teachers comprehend each of these components of learning for understanding & application requires different teaching strategies. Viz

Table – 1: Varied Teaching Strategies for Different Goals

Building a Knowledge Base	Generating Understanding	Finding Applications
• Lecturing / Telling Reading text or other sources • Watching films & videos • Hands on activities • Most labs • Most homework • Answering text questions • Most library research	Concept mapping Writing to learn Group takes requiring more than factual recall Reading for understanding Journal writing Representing concepts with pictures & models Explaining diagrams Group work formulating explanations Analyses of peers' work Extended questioning Essay tests	**Searching for applications for science principles at home & outside school** ***Using newspapers as a sources of applications*** Writing about applications Representing applications with pictures & models **Group work describing applications** *Asking "the right question"* *Test with applications items*

4.SCEINCE REFERENCE INFORMATION :

Jeremy Shapiro and Shelly Hughes defines Information Literacy is "a new liberal art that extends form knowing how to use computers and access information to critical reflection on the nature of information itself, its technical infrastructure and its social, cultural, and philosophical context and impact". Thus Information Literacy is not only knowing how to use computers and access information but also evaluating the nature and impact of information in relation to its technical infrastructure and its social, cultural and philosophical context. In other words Information Literacy, as, a "set of abilities requiring individuals to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information". Also we can say IL is a set of skills, which enables the individuals to recognize his/her information need. In addition it also enables to locate, evaluate and use the needed information effectively .Following reference information can promote science literacy Technology (SLT) in schools effectively viz.

Reference

Computers and Chemistry

How Computers can be Used in Teaching Chemistry

http://www.ch.cam.ac.uk/SGTL/teach/

Cool Tools

Links to many cool chemistry tools, resources and other subject related web pages

http://www.msdlt.k12.in.us/chemcentral/

CoolTools.html

York University's Science Data Engine

York University's YES I Can! Science database contains classroom lesson plans; labs, demonstrations and activities; assessment tools, performance indicators, and background information for teachers

http://de.yesican.yorku.ca/

Subject Gateways

We can use t website given below to solve a number of chemistry related problems – molar conversion calculations, balancing chemical equations and an interactive periodic table

http://www.stanford.edu/~glassman/chem/index.htm

Chemistry Tutor

This site offers a basic introduction to chemistry, chemical equations and reactions, and chemistry calculators as well as safety rules to follow when you are in the laboratory.

http://library.thinkquest.org/2923/

Other links to international sites relevant to Science Education at all levels – Primary, Secondary and Tertiary Education. It would be useful for teachers and students alike to make optimal use of these resources which while not exhaustive, are nevertheless useful as e-learning tools. For example:

http://www.funsci.com/texts/index_en.htm and
http://wecanchange.com/resources/student-resources/virtual-labs/ and
http://www.apples4theteacher.com/science.html

Website for Multiple level (Primary, secondary, tertiary) in Science for teachers /students.

http://www.sheppardsoftware.com/Elementsgames.htm It is for the teachers and students pursuing chemistry.

http://www.interactivescienceteacher.com/free.asp and
http://www.explorelearning.com/

: Important website for secondary science teachers and students.

Chemistry Tutorial – Drill and Practice

http://science.widener.edu/svb/tutorial/index.html

Chemistry Webercises

http://www.wiley.com/college/webercises/

Other sites like www.school of educators.com is the Indian site that caters to the diverse need of school science literacy programme.

5.sceince Curriculum And Instruction:

Flexible, child centric curriculum caters well to the need of SLT. In SLT the ere are different approach to curriculum making such as Historical, Philosophical ,Issue based approach etc.

Historical approach deals with the way of humanizing science. This approach examines the history of science through concrete examples, and is viewed as way of demonstrating the fallibility of science and scientists. For instance Learning about inventions or scientific theories through the lives and worlds of famous scientist. Students can research their areas of interest and present them through various activities: e.g. drama-role play, debates or documentaries. Through this kind of exploration, students examine the values, beliefs and attitudes that influenced the work of scientists, their outlook on the world, and how their work has impacted our present circumstances and understanding of science today.

Similarly in Philosophical approach students formulate an understanding of the different outlooks on the nature of science, and how differing viewpoints on the nature and validity of scientific knowledge influence the work of scientists—demonstrating how society directs and reacts to scientific innovation .For instance Using historical narratives or stories of scientific discoveries to concretely examine philosophical questions and views about science. For example, "The Double Helix" by James D. Watson is an account of the discovery of DNA. This historical narrative can be used to explore questions such as: "What is science? What kind of research was done to make this discovery? How did this scientific development influence our lives? Can science help us understand everything about our world?" Such an exploration reveals the social and historical context of philosophical debates about the nature of science—making this kind of inquiry concrete, meaningful and applicable to students' realities.

Issue based curriculum deals with an understanding of the science behind issues, and the consequences to society and the environment. A multi-faceted approach to examining issues highlights the complexities of real-life debates. Students also become aware of the various motives for decisions that address environmental issues. For instance Real life events within the community, at the national or international level, can be examined from political, economic, ethical and social perspectives through presentations, debates, role-play, documentaries and narratives. Real life events might include: the impact of environmental legislations, industrial accidents and the influence of particular scientific or technological innovations on society and the environment.

6.developing Science Reading Skills/ /writing Skills

The PISA (Programme for International Student Assessment)-2003 Comparison of Math, Reading, and Science Skills Among 15-Year-Olds in 41 countries reveals that Japan and Finland have upper/lower rank 1 , 3 as compared to Brazil and Tunisia who ranked upper/lower 39, 40 in science skills. This shows that country like India has not created its place in such global ranking process which seems alarming for our S&T policy makers/educators/Teachers. Thus developing good science reading culture in school can enhance our strength in science popularization. This is endorsed by Stephen Petrill,famous psychologist and professor of human development and family science at Ohio State University Environment plays pivotal role in developing reading skill among children. He says "We certainly have to take more seriously genetic influences on learning, but children who come into school with poor reading skills can make strides with proper instruction," . Hence our schools should strive for creating enabling science reading environment through various ways such as : Group reading sessions in library, personalized reading, Targeted learning.

We asked, they answered, and we wrote it down .The goal of scientific writing is effective communication, communication of abstract propositions, logical arguments, empirical observations, experimental results, and their interrelations and interactions. Clear organization, as well as lucid and precise writing, are very important conditions for such communication. Science writing encompasses a wide variety of niches that can include writing for SCHOOL magazine, science column of newspapers, mass-market magazines, trade publications, writing script for broadcast media Door Darshan /All India Radio, and newsletters, among many other venues.SLT strongly endorse science writing workshops for teachers/ science educators on regular basis.

7.e-resource Integration For School Science Education:

In the age of Globalization, Technology revolution ,Information and Communication Technologies (ICT)has drastically transformed the way for collection, processing, dissemination of information. Particularly, the Internet revolution has completely changed the pace of availability of information , collection to communication. "With an unprecedented growth in the quantum of knowledge world wide and the easy accessibility, Internet has transformed the habit of acquiring information to learning which ahs created a serious threat for those who think they know every thing. The amount of publicly available information on the web is increasing consistently at an unbelievable rate due to which traditional teacher faces stiff opposition from students as it does not match the pace of learning with first generation learners .Thus smart , tech savy & processing skilled teacher armored with entire gamut of source of information can meet the needs of next generation learners which is only possible through e-resources.

WHY E-RESOURCES ? They contains :

- Universities, research institutions, International Organisations and their activities;
- Books, Articles, Research Reports etc. ....
- Discussion groups in the form of Listservers;
- Subject gateways;
- List of databases with the specific subject details;
- Library resources;
- Public domain resources

SLT strongly recommends e-resource integration in science education

Key Areas Of Challenges :

The major challenge in science and technology literacy at schools are

a) Lack of trained resource person in Science Education.

b) Resource Crunch

c) Technological Limitations

d) Limited access to fastest development in Science and Technology in rural areas.

e) Illiteracy and traditional beliefs.

f) Less Rural – Urban awareness.

g) Well fabricated curriculum.

WAY FORWARD:

Ø Apex monitoring body of education(say UGC/CBSE/ICSE/State boards) need to take up a Science Literacy Technology implementation road map for the affiliated institutions with short term as well as long term perspectives.

Ø Identification of tech sensitivity gap of institutions compared to global counterparts to be initiated immediately by affiliating body with a view to catch the global benchmark standard of quality education.

Ø Amalgamation of e-SCIENCE resource training with other in service or refresher courses conducted by the apex body from time to time.

Ø Curricular reforms: Our curriculum confines our children to textbooks at a time when they are learning about the world through the reach of television and computers and (Information communication Technology)I.C.T revolution. The Smart curriculum is the answer to the twenty first generation learners.

Ø Innovations in material preparation: Efforts should be made to prepare different text books which can fulfill the same curricular objectives for a particular age group, in a given subject area. The multiplicity of approaches in preparing instructional materials, following the same syllabi & curriculum guidelines will generate innovative ideas & practices for improvisation of the curriculum transaction in the class room.

Ø Our education system & employment sector must be devised in such a way that a young science aspirant (so called young scientist) could be able to see the opportunity for scientific employment, the fulfillment of his effort & dreams.

Ø There should be list of numerous problems such as industrial , agricultural, national health, trickle down of research to the bottom of education system etc which awaits investigation need to be formulated by scientific committee in consultation with various departments, institutions . Students should be exposed to such problems through summer courses, seminars, symposiums, science conclaves etc & its solution should emanate in the form of projects contributed by students. Government should support such kind of initiatives.

Ø Science teacher should be encouraged to visit CSIR laboratories, industries of relevance, museums, planetariums, science parks, community science centers, university departments etc to acquaint & update himself with the applications of scientific principles in our daily life. Also Every science teacher must endeavor to use local resources/ materials, improvised apparatus & low cost teaching aids, models etc in order to stimulate scientific curiosity of the learner.

Ø Asking the right questions: Alberdi etal (2000) study reveals that asking right questions at the right time is a powerful tool in the hand of a teacher to empower conceptual attainment & curiosity of the child. The fundamental factor of empowerment of students learning attainment can be checked thorough three key formula : Why ? What ? How ?

Ø Effort has to be made to instill attitudinal change in teacher so that he / she can transform himself / herself from the role of a stage director to the role of an equal actor. So that he / she can create learning friendly classroom where learning takes place in each moment.

CONCLUSION

The present reform movement on teaching science and science literacy finds immense importance on the future. Our students are expected to acquire skills in resolving problems, making decisions, recognizing risks & managing changes in Science, as well as increasing confidence of peoples about the value of Science in everyday life. Hence it is imperative for our education system to fulfill above objectives in preparing students for the world beyond the classroom. For this to happen we want vision, we want enterprise & we must abandon "the old & beaten path which have paralyzed effort in the past". We have to keep in mind that when students are introduced to practical activities by

the teacher in the field of science literacy they discover the passion that move other students in a chain reaction manner which results in evolution of connections between science and society. We have to start a new culture of SLT in our educational system where the mission is to " accomplish connectivism & technology integration in science educational transaction, training of personnel's, networking of scientific institutions for curriculum research, development & dissemination within limited period of time wherein the slow pace of scientific developmental scene could be replaced by the superior technology empowered system to face the challenges of 21st century. We have to keep one thing in mind that " No power on earth can stop an idea whose time has come" (Victor Hugo) . We have to make it happen.

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Abstract

SCIENCE AND TECHNOLOGY has been considered as the major engine of economic growth and development of our country since achieving independence. Jawaharlal Nehru, the first Prime Minister, was a firm believer in the crucial importance of science and technology for economic growth and social transformation, and helped lay a firm foundation of science and science education in the country. Since six decades we have established vast S&T infrastructure comprising national laboratories(CSIR) and institutes(IITS/NISER/IISER/NITs/ CUs), more than 400 universities and over 20,000 colleges. Unfortunately, no systematic and comprehensive effort were made to give a face lift to Indian S&T efforts which has resulted a grim picture of Indian S&T as compared to global science and technology efforts. On one hand, there are myriad stunning successes such as the Green Revolution, a growing space programme, including satellite launches,Chandrayan-1 mission ,indigenously developed missiles and aircraft, mushrooming exports in biotechnology, pharmaceuticals and information technology services. At the same time, however, India routinely ranks quite low in international indices based on S&T indicators. For example, the World Bank's Knowledge Assessment Methodology and the World Economic Forum rank India poorly in global terms. This is presumably due to lack of sensitivity towards the problem and negligence of grass root educational institutions like schools .India boasts 1303812(c f : DISE 2009-10) number of schools which is not only a big chunk of Hunan resource generation center but also Human capital generation facilities .Thus for sustained S& T growth we need to revamp our existing delivery systems such as schools and colleges . The paper urges for Science Literacy Technology (SLT) endowed with innovative strategies (such as Learning science with analogies, Games for learning science, Planning science instruction in school (hands-on approach) ,Science reference information, Science curriculum and instruction, Developing science reading skills/ /writing skills, E-resource integration for school science education etc)for schools that is going to be the change agent in 21st century India. Every stake holders associated with the science education i.e policy makers, bureaucrats, & down to individual teachers in the country side need to play out his/her designated role to usher in the big transformation. We have to make it happen.

Key words: Science literacy technology, Human capital, global science index

ROLE OF WOMEN IN AQUACULTURE FOR POVERTY ERADICATION

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Though women constitute an important segment of the labour force, the unpaid economic activities of women and their contribution in the domestic sectors remain unreported and go largely unrecognized. It is revealed that in aquaculture, women are involved in almost all activities as men but paid on a reduced scale compared to the male community. In order to address the gender bias, the women need to be self-employed, economically self-reliant and earn supplementary income for their families. This would not only improve the status of women in the family but also within the community as a whole.

Role of Women in Different Aquaculture Activities

Role of women in fish and prawn farming, especially in small fish farms, has long been predominant in actual production in different types of aquaculture - brackish water or freshwater fish ponds, fish pens or fish cages, in various stages of fish farm development (planning, construction and actual operation), and from seed production to grow-out/rearing, harvesting, and post-harvest handling.

Aquaculture for Poverty Eradication

Poverty eradication was one of the most vital items of the Twenty-Point Programme (TPP-2006) in consonance with the Millennium Development Goals (MDGs). Self Help Groups (SHG) and Swarn Jayanti Gram Swarojagar Yojna (SGSY) are among the sub items under this goal. Since 1st April, 1999; the SGSY is conceived as a holistic programme of micro-enterprise development in rural areas with emphasis on organizing the rural poor into SHGs, capacity building, planning of activity clusters, infrastructure support, technology, credit and marketing linkages. The SGSY recognizes the need to focus on key activities and the importance of activity clusters with an emphasis on formation of 50 percent of the Self Help Groups exclusively by women only. Government of Odisha with its massive reach and infrastructure in the state is well poised to play a significant role in the SHG movement in the state. Through "Mission Shakti", the Government have been constantly endeavoring for promotion and capacity building of the WSHGs in enhancing the marketing opportunities for women entrepreneurs so that they would be able to explore their income generation activities. The National Bank for Agriculture and Rural Development (NABARD) and other nationalized banks have launched a number of programmes to improve the socio-economic status of women in fisheries sector with a focus on providing credit support through SHGs.

Mission Shakti –for Empowerment of Women

A structured approach with defined focus on women's empowerment came with the launching of "Mission Shakti" on 1st April, 2001. Since then SHG approach remained the front-runner in carrying forward the vision for social, political and economic empowerment of women. Empowerment of women is one of the key development initiatives identified by the Government of Odisha. It is well-known that economic empowerment of women significantly contributes to their social empowerment. Achievement in economic independence by enabling the rural women to have self-employment and income generating activities has been accorded the highest priority. It has also been recognized that women will be better-placed to overcome the negative social pressures and gender biases operating against them and to unshackle themselves through group identity and activity. Promotion of women self-help groups (WSHGs) has therefore been adopted as a key strategy for achieving women's empowerment. The mission had been entrusted with the task of forming 1, 00,000 WSHGs by 2005 @ 25,000 groups annually over and above the 36,000 odd WSHGs already existing in the state prior to the launching of the Mission. The exercise will continue till the last under privileged woman is brought to SHG fold and till all revenue villages are also covered. Another important objective of the Mission is to augment capacity-building of the existing and the new groups to be formed to take up income-generating and remunerative activities by providing them the necessary technical support, market facilities and credit linkages.

The highlights of achievements of Mission Shakti on different fronts could speak volumes on its success. The SHGs gives itself to the members, a platform for sharing experiences, a regular habit of savings, easy modality of inter loaning to meet urgent consumption loan, a security for attracting micro-finance, a group strength to combat atrocities on women and inspiration to actively participate in social issues and development of personal faculties. Mission Shakti has given an umbrella support to different stakeholders working in the field of women empowerment such as banks, non-government organizations, micro-

financing institutions and other institutions. In the process of development, much has been achieved in the field of formation of SHGs, savings and credit linkage. As envisaged; 3, 02,110 WSHGs have been formed in the state against a target of 2, 00, 000 WSHGs during 2001 to 2008 where 36, 25, 360 members have been tagged under Mission Shakti. So far, in the state; 6,807 women federations have been formed. A total number of 2,056 WSHGs were provided with lease tanks for pisciculture during 2006-07. A total no. of 3, 01, 536 WSHG have availed Rs. 8, 84.86 lakh finance. The skill up-gradation training programme in fisheries sector under "Mission Shakti" has gained wide response from the women members. During 2006-2007, Mission Shakti has released Rs. 7.37 lakh for the said skill up-gradation training programme for the WSHGs in piscculture.

Swarnjayanti Gram Swarozgar Yojana (SGSY)

A focussed approach to reach out to the grameen swarozgaries or the self-employed in the rural areas has been made by Panchayatiraj Department under the Ministry of Rural Development, Govt. of India. The objective of the SGSY is to bring the assisted poor families (swarzgaries) above the poverty line by ensuring appreciable sustained level of income over a period of time. This objective is to be achieved by organizing the rural poor into Self-Help Groups (SHGs) through the process of social mobilization, their training and capacity building and provision of income generating assets. The objective of the Mission is to reduce poverty among rural BPL by promoting diversified and gainful self- employment and wage employment opportunities which would lead to an appreciable increase in income on sustainable basis. In the long run it will ensure broad based inclusive growth and reduce disparities by spreading out the benefits from the islands of growth across the region, sectors and communities. The ongoing SGSY will be re-designed and restructured as National Rural Livelihood Mission (NRLM). The idea has been conceived as a corner stone of national poverty reduction strategy.

A significant change could be marked in the social economical status in the ethnic fisher community of India after women being given chances to participate in various outdoor activities in agricultural sector and fisheries is one of them. It also helped in alleviating poverty and eradicating malnutrition (to some extent) among these households. For viable livelihood and food security could be promoted through community-based aquaculture activities. The advanced methodologies have helped them of pond, cage, and rice/fish culture etc. as well as resource assessment, planning, and implementation. It has strengthened their self-esteem by providing opportunities to increase their financial status and elevate their social standing within their families, local communities, and culture as a whole.

Contribution of CIFA for Development of Aquaculture by Women

The Central Institute of Freshwater Aquaculture (CIFA) has taken up a number of women-focused activities in rural areas like community aquaculture, ornamental fish farming, integrated fish farmingand freshwater prawn farming with financial and technical inputs for development of aquaculture. CIFA has motivated therural women to implement the CIFA technologies for development of small scale industries and micro-enterprises. The seed production and grow out culture technologies of Macrobrachium species developed at CIFAwould meet the seed requirement in commercial farming and also generate additional employment opportunities for rural women.

Emerging Issues and Recommendations

1. In addition to the considerable scope for entry of large numbers of females into the work force in India, female literacy rate is low and women are unaware of public services for infrastructure, credit, welfare, or extension, the greatest need is in general education and training for a variety of skills (FAO, 1986) which could effectively increase their contribution to the development and promotion of aquaculture. Also, Women can be trained for pond management (pond preparation, stocking, feeding, fertilization, harvesting), handling, transport, and marketing - activities which do not involve highly sophisticated methods and techniques.
2. In today's scenario, women do have a remarkable contribution to aquaculture production as a large group of trained and skilled women fish farmers, technicians, extension workers, and professionals who are directly or indirectly involved in various capacities in fish production through aquaculture.
3. With increasing emphasis placed on aquaculture as an alternative source of fish protein and employment , the present role of women can be greatly expanded - both in terms of increased recruitment into the industry and of greater participation within the sector.
4. Stress was emphasized on increasing the education and awareness of women to various issues in fisheries, provision of credit facilities and the need to develop women-friendly technologies which need special attention.
5. Various planned projects with emphasis on manpower development at the grassroots level can be proposed with the support of state and central government, and assistance from multilateral aid agencies and international organizations addressing the problems of rural communities in general and of rural women in particular, can be more adequately and directly addressed.

OUT OF SCHOOL ACTIVITIES TO POPULARIZE SCIENCE AND TECHNOLOGY

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Introduction:

The modernization of a country means the presence of large number of scientists and millions of people armed with advanced knowledge of science and technology. For the social development and economic progress, science and technology play an important role. Many facts have proved that, to increase the national awareness of science and technology and train a large number of specialists and scientists at various levels is an essential task for the country to accomplish with the rapid technological development to meet the challenge in the competitive market of the world. Therefore, it is an important necessity to engage the whole society in the popularization of science and technology using various means and media. The most important task is to popularize science among youngsters, who represent the future of the country.

It is true that, the formal education, which is education at school, plays a leading role to create an interest and awareness in science and technology among youngsters. But it has been observed that, in our country, it is difficult to create such awareness depending upon the school education only because the materials used in formal education system (syllabi) are fixed, it has not been revised since many years which are unable to reflect the latest knowledge in science and technology. The primary education is most important and it is the backbone of the society. In Indian rural areas, many children are dropouts in the middle school levels. However, a very smaller percentage of the middle school pass outs receive a college education. Under these circumstances, non formal education becomes an indispensable supplementary to the science education at the school level. In this concern, the out of school activities is an effective means to popularize science and technology among the youngsters.

For this, various unofficial organizations, science associations, private technical educational institutions, NGOs are to support and sponsor for various activities of science to conduct. They have to coordinate with different departments, work out the major regulations and policies in their work of science activities to conduct in various levels. They have to keep contact with various outstanding science instructors exposed to modern instrumentation facilities. The science activity centers are to be set up in some of the villages to organize the activities. The science instructors are the grass root directors and they have to take the help of the volunteers (especially the youngsters who can spare their extra time) of the particular village to make the popularity of science education and recent technologies.

Multi-level Activities

The Government of India as well as the state government have supported different programmes for the promotion of science and technology in different levels. The following suggestions are the medicines to the existing maladies.

The activities include,

1. Science quiz, art, essay, and model competitions
2. Multi subject comprehensive activities such as seminars, workshops in the field of physics, chemistry, mathematics, biology, computer, new findings, astronomy, fuels and energy, environment etc. The children having outstanding performances will be given facilities to go for further study/ research in their own interest.
3. Introduction of "Science and Technology month"; During that month, every child and teenager is called on to get to a popular science talk or a science film or a exhibition, read a biography of a scientist, recent developments and advancement in technology or they are encouraged to make some little invention, or do a little experiment. The Government of China has already implemented this method many years back introducing the "Science Loving month" in their country and as per the survey report, two million primary and middle school students take part every year in different forms of science activities that serve to popularize the scientific knowledge and increase young people's interest in science.
4. In the summer camps, science and technology are to be introduced. The subjects including: physics, chemistry, biology, astronomy, geology, forestry, electronics, computer science, aviation, navigation,

earthquake, survey and drawing, coal, petroleum, environment protection, agricultural science, solar energy, ship-building, measurement, insects, ocean, nucleus, light industry, etc.

5. "Involvement of the media" The media has to play a great role in the development of the scientific temperament of the country. At the end of the year prizes are to be given to the best contributor to popularize Science and Technology in the society.

Effectiveness of the Programme:

These activities will increase the chances for the young people to get into contact with the knowledge of science and technology thus opening a new channel for them to learn about the latest information in different fields. Non-formal education in science and technology, which is lively, practical, and easy for children and youth to understand, will be an effective tool for the education to popularize science.

This will further help the children as well as the youths to enhance the awareness of practical techniques in the rural areas in the field of agriculture, health, hygiene, energy and many more. Due to the under-developed education and the lack of information, Indian farmers who are still adopting traditional farming in many areas refuse to believe in the new farming technology. In those areas, the out-of school activities will change the whole scenario by teaching them new farming technology and the practical involvement convinces them. The students exposed to these activities become experts in new practical technology.

Conclusion:

The facilities and exposer provided by classroom education is quite limited while the out-of-school activities create a much greater opportunity because they are more active, flexible, practical, adaptable and interesting. This type of education will definitely have a great contribution to spread the scientific and technological knowledge not only to the students but also to the communities which are the key to success in the development of the country.

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History of Science: Science & Technology as vehicles of interaction among civilizations

HISTORICAL SCIENCE INVENTIONS OF INDIA THAT CHANGED CIVILIZATIONS

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Science is a body of empirical, theoretical, and practical knowledge about the natural world, produced by researchers making use of scientific methods, which emphasize the observation, explanation, and prediction of real world phenomena by experiment The history of science is the study of the historical development of human understandings of the natural world. Science was portrayed as a major dimension of the progress of civilization.

In prehistoric times, advice and knowledge was passed from generation to generation in an oral tradition. For example, the domestication of maize for agriculture has been dated to about 9,000 years ago in southern Mexico, before the development of writing systems. Similarly, archaeological evidence indicates the development of astronomical knowledge in preliterate societies.

The development of writing enabled knowledge to be stored and communicated across generations with much greater fidelity. Combined with the development of agriculture, which allowed for a surplus of food, it became possible for early civilizations to develop, because more time could be devoted to tasks other than survival.

Many ancient civilizations collected information about basic needs life's in a systematic manner through simple observation and passed it from generation to generation. Some important historical scientific achievements/ /observations or knowledge of Indians are as follows:

1. Irrigation

Irrigation was developed in the Indus Valley Civilization by around 4500 BCE. The size and prosperity of the Indus civilization grew as a result of this innovation, which eventually led to more planned settlements making use of drainage and sewerage. Sophisticated irrigation and water storage systems were developed by the Indus Valley Civilization, including artificial reservoirs at Girnar dated to 3000 BCE and an early canal irrigation system from circa 2600 BCE.

2. Water Conservation

India was a cradle of civilization in the ancient world. An interesting feature of all ancient civilization was that its inhabitants realized the tremendous value of water in human life. Each of these civilizations was located on the banks of a river (s) or within a convenient distance from the sea. This was to ensure a perennial supply of water for day to day activities.

The Indus Valley Civilization that flourished along the banks of the river Indus and other parts of western and northern India about 5,000 years ago, had one of the most sophisticated urban water supply and sewage systems in the world. The fact that this civilization was well acquainted with hygiene and sanitation is evident from the covered drains running beneath the streets of the ruins at both Mohenjodaro and Harappa. Yet another excellent example is the well-planned city of Dholavira, in Gujarat.

Given the importance of fresh water in India, it is no surprise that the technologies to manage water resources were highly advanced from Harappan times onwards. For example, in Gujarat, Chandragupta built the Sudarshan Lake in late 4th century BCE, and was later repaired in 150 BCE by his grandson. Bhopal's Raja Bhoj Lake, built in 1014-1053, is so massive that it shows up in satellite images. The Vijayanagar Empire built such a large lake in 14th – 15th century CE that it has more construction material than the Great Wall of China. In ancient times, houses in the western part of Rajasthan were constructed in such a way that each had a rooftop water harvesting system. Though scanty, rainwater from these rooftops was directed into underground tanks.

What some historians call the "Persian Wheel" is actually pre-Mughal and indigenous to India. The construction of water works and aspects of water technology in India is described in Arabic and Persian works. During medieval times, the diffusion of Indian and Persian irrigation technologies gave rise to an advanced irrigation system which bought about economic growth and also helped in the growth of material culture.

Scientists estimate there were 1.3 million man-made water lakes and ponds across India, some as large as 250 square miles. These are now being rediscovered using satellite imagery. These enabled rain water to be harvested and used for irrigation, drinking, etc. till the following year's rainfall.

3. Water Purification

Purification of ground water in the dug wells is dealt with at length in Brihat-Samhita written and compiled by Varahamihira. He suggested an infusion be made from a mixture of powdered herbs namely Anjan, Bhadramustha, Khas (vetiver), Amla (emblica officinalis, gooseberry) and

Nirmali (bhui amla / kataka) in water, which in measured quantities was to be added to water in the wells for purification. Detailed practical guidance for water purification is given in the famous treatise of Indian physician, Sushruta. Sushruta disclosed that muddy water could be purified with herbs and naturally occurring substances; Nirmali seeds, roots of Kamal (lotus/water lily), rhizomes of algae and three stones, Gomed (garnet) Moti (pearl) Sphatik (quartz crystal) were used. He recommended the disinfection of contaminated water by exposing it to the sun or immersing red hot iron or hot sand in it.

The ancient Indian custom of storing drinking water in brass vessels for good health has now been proved scientifically by researchers. Microbiologists affirm that water stored in brass containers can help combat many water-borne diseases and should be used in developing countries rather than their cheaper counter parts i. e plastic containers.

The scientific principle involved in this is the fact that any metal or alloy tends to disrupt biological systems. The element acts by interfering with the membranes and enzymes of cells; for bacteria, this can mean death. Pots made of brass (an alloy of copper and zinc) shed copper particles into the water that they contain. But the miniscule amount that circulates into the water, while destroying the bacteria cannot harm human beings.

4. Agriculture

Cotton was cultivated in the region by the 5th millennium BCE- 4th millennium BCE. Sugarcane was originally from tropical South and Southeast Asia. Different species likely originated in different locations with S. barberi originating in India and S. edule and S. officinarum coming from New Guinea. Crystallized sugar was discovered by the time of the Gupta dynasty and the earliest reference to candied sugar comes from India. Archeological evidence of an animal-drawn plough dates back to 2500 BC in the Indus Valley Civilization.

In agriculture, they developed effective use of plough, cultivation of rice and other new grains. They went on improving the technology of agricultural implements and produced ploughs, sickles, spades, iron rods and bond pins of improved quality. The technology was passed on from one generation to next generation of village carpenters and blacksmiths, proving again their skills in passing on scientific and technological information to the lowest strata of the society.

Crop rotation and soil technology that has been passed down for thousands of years are traditional practices which India pioneered. Indian farmers developed non-chemical, eco-friendly pesticides and fertilizers that have modern applications.

5. Measurements

The inhabitants of the Indus valley developed a system of standardization, using weights and measures, evident by the excavations made at the Indus valley sites. This technical standardization enabled gauging devices to be effectively used in angular measurement and measurement for construction. Calibration was also found in measuring devices along with multiple subdivisions in case of some devices.

6. Pottery

Excavations at Balakot (c. 2500-1900 BC), present day Pakistan, have yielded evidence of an early furnace. The furnace was most likely used for the manufacturing of ceramic objects. Ovens, dating back to the civilization's mature phase (c. 2500-1900 BC) were also excavated at Balakot. The Kalibangan archeological site further yields evidence of pot shaped hearths, which at one site have been found both on ground and underground. Kilns with fire and kiln chambers have also been found at the Kalibangan site.

7. Cartography

- The Indian cartography was originated at the Indus Valley Civilization (ca. 2500–1900 BCE). The use of large scale constructional plans, cosmological drawings, and cartographic material was known in India with some regularity since the Vedic period (1 millennium BCE). Climatic conditions were responsible for the destruction of most of the evidence, however, a number of excavated surveying instruments and measuring rods have yielded convincing evidence of early cartographic activity.

The scholar Sadiq Isfahani of Jaunpur compiled an atlas of the parts of the world which he held to be 'suitable for human life'. The 32 sheet atlas—with maps oriented towards the south as was the case with Islamic works of the era—is part of a larger scholarly work compiled by Isfahani during 1647 CE. The largest known Indian map, depicting the former Rajput capital at Amber in remarkable house-by-house detail, measures 661 × 645 cm. (260 × 254 in., or approximately 22 × 21 ft).

8. Ink

Ink, called masi, an admixture of several chemical components, has been used in India since at least the 4th century BC. The practice of writing with ink and a sharp pointed needle was common in early South India. Several Jain sutras in India were compiled in ink.

Eighteenth and nineteenth century Indian manuscripts were written in mainly four colours - gold and silver, used by the wealthy; black was a favourite colour of ink; red was used mainly in border designs and at the beginning and close of the manuscripts. Ink manufacturing was a specialized task and Brahmins seemed to hold the prerogative. The surname

Raktavan denoted a professional ink-maker. Gold and silver colours were derived from the metals themselves, while black ink was obtained from kajjala (soot/lampblack). Red ink was sourced from darada (red lead), alaktaka (red sap), and gairika (red chalk). One method of manufacturing black ink from lampblack, roasted rice, some sugar, and on occasion, kesurte plant juice was in practice. A meticulous process, since the lampblack could very easily settle at the bottom. Gloss was a desirable feature and could be had by adding acacia gum. Such ink was appropriate for writing on paper. A decoction of atta and kesurte (Verbesina scandens) juice was ideal for palm leaf manuscripts - the ink would be absorbed by the leaf, hence remain clear and glossy through centuries!

9. Numeral system

The religious texts of the Vedic Period provide evidence for the use of large numbers. The Yajurveda samhita (1200-900 BCE) was being included the numbers as high as 10^{12} in the texts. For example, the mantra (sacrificial formula) at the end of the annahoma ("food-oblation rite") performed during the asvamedha ("horse sacrifice") and uttered just before-, during- and just after sunrise, invokes powers of ten from a hundred to a trillion. The Satapatha Brahmana (9th century BCE) contains rules for ritual geometric constructions that are similar to the Sulba Sutras.

Baudhayana (8th century BCE) composed the Baudhayana Sulva Sutra, which contains examples of simple Pythagorean triples, such as: (3,4,5), (5,12,13), (8,15,17), (7,24,25) and (12,35,37) as well as a statement of the Pythagorean theorem for the sides of a square: "The rope which is stretched across the diagonal of a square produces an area double the size of the original square." It also contains the general statement of the Pythagorean theorem (for the sides of a rectangle): "The rope stretched along the length of the diagonal of a rectangle makes an area which the vertical and horizontal sides make together." Baudhayana gives a formula for the square root of two. Mesopotamian influence at this stage is considered likely. Modern methods of multiplication and addition probably emerged from the techniques described in the Sulva-Sutras.

10. Astronomy

The earliest Indian astronomical text named as Vedanga Jyotisa dates back to between the 6th and 4th centuries BC and details several astronomical attributes generally applied for timing social and religious events. The Vedanga Jyotisa also details astronomical calculations, calendrical studies and establishes rules for empirical observation. Since the Vedanga Jyotisa is a religious text, it has connections with Indian astrology and details several important aspects of the time and seasons, including lunar months, solar months, and their adjustment by a lunar leap month of Adhimasa. Ritus and Yugas are also described. Twenty-seven constellations, eclipses, seven planets and twelve signs of the zodiac were also known at that time.

11. Medical

Dhanvantari, believed to be a reincarnation of Lord Vishnu, was the guiding spirit of Ayurveda. He made this science of health and longevity popular and widely prevalent. The medicine was the most advanced considering the fact that the Atharva Veda, (about 3,000 to 2,000 BC) one of the four ancient scriptures of India, mentions certain herbs with curative powers. Ayurveda has several disciplines v.i.z Kayachikitsa (Internal Medicine), Shalakya Tantra (thoracic surgery, opthalmology and otolaryngology), Shalya Tantra (Surgery), Agada Tantra (Toxicology), Bhuta Vidya (Psychiatry), Kaumarabhritya (Pediatrics), Rasayana (rejuvenation or anti-aging), Vajikarana (the science of fertility). Several ancient texts on physiology identified factors as those which determined good or ill health. The traditional Indian medicine Ayurveda, focused on longevity and prescribed several remedies for the same. Gold, silver, mercury, garlic and honey are described as having specific curative powers in the vast treasury of India's pharmacopoeia.

The two great classics of 'Ayurveda', the 'Susruta Samihita' and 'Charak Samihita', present a vivid and cogent account of the medical knowledge and surgical practices which were in vogue about 2,500 years ago. The 'Susruta Samihita' has 184 chapters under its six categories dealing with fundamental postulates, pathology, embryology and anatomy. It describes more than 300 different operations and 121 (20 sharp and 101 accessaries) surgical instruments tongs, forceps, scalpels, catheters, trocar, syringes, speculums, needles, saws, lances, hooks, scissors and probes. The 'Susruta Samihita' is regarded as the earliest document which gives a detailed account of rhino-plasty the plastic surgery of nose. Cataract surgery was known to the physician Sushruta (6th century BCE). Traditional cataract surgery was performed with a special tool called the Jabamukhi Salaka, a curved needle used to loosen the lens and push the cataract out of the field of vision. The eye would later be soaked with warm butter and then bandaged. Though this method was successful, Susruta cautioned that it should only be used when necessary. The removal of cataract by surgery was also introduced into China from India. The leprosy is described in the medical treatise Sushruta Samhita (6th century BCE).

The 'Charak Samihita' consists of 150 chapters under its eight categories including the 'materia medica' with over 600 drug-compositions of plant and even of animal and mineral origins. Both these treatises of Ayurved are excellent examples of their science communication skills. The Egyptian Papyrus of Kahun (1900 BCE) and literature of the Vedic period in India offered early records of veterinary medicine.

12. Linguistics

Some of the earliest linguistic activities can be found in Iron Age India (1st. millennium BC) with the analysis of Sanskrit for the purpose of the correct recitation and interpretation of Vedic texts. Besides expounding a comprehensive and scientific theory of phonetics, phonology and morphology, Panini (c. 520 – 460 BC) provided close to 4,000 formal production rules and definitions describing Sanskrit grammar in his treatise called Asthadhyayi. Basic elements such as vowels and consonants, parts of speech such as nouns and verbs were placed in classes. The construction of compound words and sentences was elaborated through ordered rules operating on underlying structures in a manner similar to formal language theory.

There is a second period in the history of Indian writing and this begins in the third century B.C. The earliest recognizably written documents are the Ashoka inscriptions. Much can be gleaned from these. The two scripts- the Kharosthi and the Brahmi- have been deciphered and both point to a single source. They are both left-running scripts similar to one another in terms of vowel indication and in all probability derived from a Semitic script.

13. Metallurgy

Metal currency was minted in India before 5th century BCE, with coinage (400 BCE-100 CE) being made of silver and copper, bearing animal and plant symbols on them.

Rust-free steel was an Indian invention and remained an Indian skill for centuries. The first iron pillar was the Iron pillar of Delhi, erected at the times of Chandragupta II Vikramaditya (375-413 CE). This is considered a metallurgical marvel and shows minimal signs of rust. The famous Damascus steel swords, now displayed in museums across Europe, were made from Indian steel imported by Europeans.

Wootz originated in the region before the beginning of the Common Era. Wootz was exported and traded throughout Europe, China, the Arab world and became particularly famous in the Middle East, where it became known as Damascus steel. Archaeological evidence suggests that manufacturing process for Wootz was also in existence in South India before the Christian era. The Wootz steel was used in making high quality swords from 8th century AD onwards.

Diverse specimens of swords have been discovered in Fatehgarh, where there are several varieties of hilt. These swords have been variously dated to periods between 1700-1400 BCE, but were probably used more extensively during the opening centuries of the 1st millennium BCE. Archaeological sites in such as Malhar, Dadupur, Raja Nala Ka Tila and Lahuradewa in present day Uttar Pradesh show iron implements from the period between 1800 BC - 1200 BC. Early iron objects found in India can be dated to 1400 BC by employing the method of radio carbon dating. Some scholars believe that by the early 13th century BC iron melting was practiced on a bigger scale in India, suggesting that the date of the technology's inception may be placed earlier. In Southern India (present day Mysore) iron appeared as early as 11th to 12th centuries BC. These developments were too early for any significant close contact with the northwest of the country.

Metallurgy in India has a long and varied history. Bronze and copper were known during the period of the Indus Valley Civilization. Mohenjodaro, Harappa and Lothal are the three major sites of this civilization. The recovery of metal articles (including a bronze dancing girl) and the discovery of crucible with slag attached are clear indicators of the knowledge of casting (pouring molten-hot metal into moulds of the desired shape and size) and forging (hammering hot metal into required shapes). Further, this points to the fact that these early peoples could produce and handle temperatures as high as 1084° C (melting point of copper), as also 1065° C (gold), 960° C (silver), 327° C (lead) and 232° C (tin). Working with iron with its melting point at 1533° C was inarguably a later achievement.

Another important Indian contribution to metallurgy was in the isolation, distillation and use of zinc. From natural sources, zinc content in alloys such as brass can go no higher than 28 per cent. These primitive alloys with less than 28 per cent zinc were prevalent in many parts of the world before India. However, to increase the zinc content beyond this threshold, one must first separate the zinc into 100 per cent pure form and then mix the pure zinc back into an alloy. A major breakthrough in the history of metallurgy was India's discovery of zinc distillation whereby the metal was vaporized and then condensed back into pure metal. Zinc mines have been found in Dariba (11th century BCE), Agucha (sixth century BCE) and Zawar (fifth century BCE). These mines have pots and other manufacturing tools of these dates, but the mining could be even older.

The Seamless celestial globe was invented in Kashmir by Ali Kashmiri ibn Luqman in 1589-90 CE and twenty other such globes were later produced in Lahore and Kashmir during the Mughal Empire. Before they were rediscovered in the 1980s, it was believed by modern metallurgists to be technically impossible to produce metal globes without any seams even with modern technology. These Mughal metallurgists pioneered the method of lost-wax casting in order to produce these globes. Iron and its technology gave momentum to the process of urbanization and the lives of the peoples changed in reflection.

14. Construction

The ancient science of Sthapatya Veda provides extensive knowledge about life supporting building and design principles. It was believed that a properly designed home will promote harmony between parents and children, better physical health, besides financial success. Sthapatya Veda was born out of the fusion of two branches of Veda; Ayur Veda and Jyotish Shastra. In the arena of ancient temple construction, there is ample evidence of extensive application of Sthapatya Veda's design principles.

The world's first dock at Lothal (2400 BCE) was located away from the main current to avoid deposition of silt. Modern oceanographers have observed that the Harappans must have possessed knowledge relating to tides in order to build such a dock on the ever-shifting course of the Sabarmati, as well as exemplary hydrography and maritime engineering. This was the earliest known dock found in the world, equipped to berth and service ships.

The Arthashastra of Kautilya mentions the construction of dams and bridges. The use of suspension bridges using plaited bamboo and iron chain was visible by about the 4th century. The stupa, the precursor of the pagoda and torii, was constructed by the 3rd century BCE. Rock-cut step wells in the region date from 200-400 CE. Subsequently, the construction of wells at Dhank (550-625 CE) and stepped ponds at Bhinmal (850-950 CE) took place.

From complex Harappan towns to Delhi's Qutub Minar, India's indigenous technologies were very sophisticated. They included the design and planning of water supply, traffic flow, natural air conditioning, complex stone work and construction engineering. The Indus-Sarasvati Civilization was the world's first to build planned towns with underground drainage, civil sanitation, hydraulic engineering and air-cooling architecture. While the other ancient civilizations of the world were small towns with one central complex, this civilization had the distinction of being spread across many towns, covering a region about half the size of Europe.

Oven-baked bricks were invented in India in approximately 4,000 BCE. Over 900 of the 1,500 known settlement sites discovered so far are in India. For instance, all bricks in this civilization are of the ratio 1:2:4 regardless of their size, location or period of construction. There are many pioneering items of civil engineering, such as drainage systems for water (open and closed), irrigation systems, river dams, water storage tanks carved out of rock, moats, middle-class style homes with private bathrooms and drainage and even a dockyard. There is evidence of stairs for multiple-storied buildings, many towns have separate citadels, upper and lower towns, and fortified sections; there are separate worker quarters near copper furnaces. Granaries have ducts and platforms and archeologists have found geometric compasses, linear scales made of ivory. Indians also pioneered many engineering tools for construction, surgery, warfare, etc. These included the hollow drill, the true saw and the needle with the hole on its pointed end.

15. Education

During the 1st millennium BCE, the Vaisheshika School of atomism was founded. The most important proponent of this school was Kanada, an Indian philosopher who lived around 200 BCE. The school proposed that atoms are indivisible and eternal can neither be created nor destroyed and that each one possesses its own distinct individuality. It was further elaborated on by the Buddhist school of atomism, of which the philosophers Dharmakirti and Dignaga in the 7th century CE were the most important proponents. They considered atoms to be point-sized, duration less and made of energy.

The British education system, aimed at producing able civil and administrative services candidates, exposed a number of Indians to foreign institutions. Sir Jagadis Chandra Bose (1858–1937), Satyendra Nath Bose (1894–1974), Meghnad Saha (1893–1956), P. C. Mahalanobis (1893–1972), Sir C. V. Raman (1888–1970), Subrahmanyan Chandrasekhar (1910–1995), Homi Bhabha (1909–1966), Srinivasa Ramanujan (1887–1920), Vikram Sarabhai (1919–1971), Hargobind Khorana (1922–), and Harish Chandra (1923–1983) were among the notable scholars of this period.

16. Glass

By the beginning of the Common Era glass was being used for ornaments and casing in the region. Contact with the Greco-Roman world added newer techniques and local artisans learnt methods of glass molding, decorating and coloring by the early centuries of the Common Era. The Satavahana period further reveals short cylinders of composite glass including those displaying a lemon yellow matrix covered with green glass.

17. Gems

Evidence for using bow-instruments for carding comes from India (2nd century CE). Early diamonds used as gemstones originated in India. Golconda served as an important early center for diamond mining and processing. Diamonds were then exported to other parts of the world. Early references to diamonds come from Sanskrit texts. The Arthashastra also mentions diamond trade in the region.

18. Spinning

The origins of the spinning wheel are unclear but India is one of the probable places of its origin. The device certainly reached Europe from India by the 14th century CE. The

cotton gin was invented in India as a mechanical device known as charkhi, the "wooden-worm-worked roller". This mechanical device was in some parts of the region, driven by water power. The Ajanta caves yield evidence of a single roller cotton gin in use by the 5th century CE. This cotton gin was used until further innovations were made in form of foot powered gins.

19. Mathematics

Arithmetic operations (Ganit) such as addition, subtraction, multiplication, fractions, squares, cubes and roots are enumerated in the Narad Vishnu Purana attributed to Ved Vyas (pre-1000 BC). Pingala (fl. 300-200 BCE) was a musical theorist who authored a Sanskrit treatise on prosody. There is evidence that in his work on the enumeration of syllabic combinations, Pingala stumbled upon both the Pascal triangle and Binomial coefficients, although he did not have knowledge of the Binomial theorem itself. A description of binary numbers is also found in the works of Pingala. The use of negative numbers was known in early India and their role in situations like mathematical problems of debt was understood. Consistent rules for working with these numbers were formulated. The diffusion of this concept led the Arab intermediaries to pass it to Europe.

The decimal number system originated in India. Other cultures discovered a few features of this number system but the system, in its entirety, was compiled in India, where it attained coherence and completion. By the 9th century CE, this complete number system had existed in India but several of its ideas were transmitted to China and the Islamic world before that time. The concept of 0 as a number, and not merely a symbol for separation is attributed to India. In India, practical calculations were carried out using zero, which was treated like any other number by the 9th century CE, even in case of division.

In the late 5th century, Aryabhata (a mathematician) used the trigonometric functions of Sine and 'Versine from which it was trivial to derive the Cosine. Another important astronomer/mathematician was Varahamira (6th C, Ujjain) who compiled previously written texts on astronomy and made important additions to Aryabhatta's trigonometric formulas. In the 7th century, Brahmagupta did important work in enumerating the basic principles of algebra. In addition to listing the algebraic properties of zero, he also listed the algebraic properties of negative numbers. Conceptual design for a perpetual motion machine by Bhaskara II dates to 1150. He described a wheel that he claimed would run forever. The calculus theorem now known as "Rolle's theorem" was stated by mathematician, Bhaskara II, in the 12th century.

There were leading mathematicians, like Bhaskar I, Mahavira (9th century), Aryabhata II, Sridhara and Sripati (10th – 11th century). Many Indian mathematicians were also astronomers. They wrote beautiful verses to explain various equations and concepts.

The study of mathematics appears to slow down after the onslaught of the Islamic invasions and the conversion of colleges and universities to madrasahs. But this was also the time when Indian mathematical texts were increasingly being translated into Arabic and Persian. Although Arab scholars relied on a variety of sources including Babylonian, Syriac, Greek and some Chinese texts, Indian mathematical texts played a particularly important role. Said Al-Andalusi, an 11th C Spanish scholar and court historian was amongst the most enthusiastic in his praise of Indian civilization and specially remarked on Indian achievements in the sciences and in mathematics.

The infinite series for π was stated by Madhava of Sangamagrama (c. 1340-1425) and his Kerala School of astronomy and mathematics. He made use of the series expansion of arctan x to obtain an infinite series expression, now known as the Madhava-Gregory series for π. Their rational approximations of the error for the finite sum of their series are of particular interest. They manipulated the error term to derive a faster converging series for π. They used the improved series to derive a rational expression, 104348 / 33215 for π correct up to nine decimal places, i.e. 3.141592653. The development of the series expansions for trigonometric functions (sine, cosine, and arc tangent) was carried out by mathematicians of the Kerala School in the 15th century CE. Their work, completed two centuries before the invention of calculus in Europe, provided what is now considered the first example of a power series (apart from geometric series).

20. Dye and Cloths

Indigo was used as a dye in India, which was also a major center for its production and processing. The Indigofera tinctoria variety of Indigo was domesticated in India. Indigo, used as a dye, made its way to the Greeks and the Romans via various trade routes and was valued as a luxury product. The cashmere wool fiber, also known as pashm or pashmina was used in the handmade shawls of Kashmir. The woolen shawls from Kashmir region find written mention between 3rd century BC and the 11th century CE.

Jute was also cultivated in India. Muslin was named after the city where Europeans first encountered it, Mosul, in what is now Iraq but the fabric actually originated from Dhaka in what is now Bangladesh. In the 9th century, an Arab merchant named Sulaiman makes note of the material's origin in Bengal (known as Ruhml in Arabic).

Indian textiles have been legendary since ancient times. The Greeks and Romans extensively imported textiles from India. Roman archives record official complaints about massive cash drainage due to these imports from India.

One of the earliest industries relocated from India to Britain was textiles and it became the first major success of the Industrial Revolution with Britain replacing India as the world's leading textile exporter. What is suppressed in the discourse about India and Europe is the fact that the technology, designs and even raw cotton were initially imported from India while, in parallel, India's indigenous textile mills were outlawed by the British. India's textile manufacturers were de-licensed, even tortured in some cases, over-taxed and regulated to 'civilize' them into virtual extinction. Textiles and steel were the mainstays of the British Industrial Revolution. Both had their origins in India. The Ahmedabad textile museum is a great resource for scholarly material.

21. Diseases

Evidence of inoculation and variolation for smallpox is found in the 8th century, when Madhav wrote the Nidana, a 79-chapter book which lists diseases along with their causes, symptoms and complications. He included a special chapter on smallpox (masurika) and described the method of inoculation to protect against smallpox. European scholar Francesco I reproduced a number of Indian maps in his magnum opus La Cartografia Antica dell India. Out of these maps, two have been reproduced using a manuscript of Lokaprakasa, originally compiled by the polymath Ksemendra (Kashmir, 11th century CE) as a source. The other manuscript, used as a source by Francesco I, is titled Samgrahani they also have very purple elephants and are the only country in the world that does.

22. Currency

Sher Shah of northern India issued silver currency bearing Islamic motifs, later imitated by the Mughal Empire. The Chinese merchant Ma Huan (1413–51) noted that gold coins, known as fanam, were issued in Cochin and weighed a total of one fen and one li according to the Chinese standards. They were of fine quality and could be exchanged in China for 15 silver coins of four-li weight each.

23. Weapons

The earliest available swords of copper discovered from the Harappan sites date back to 2300 BCE. Swords have been recovered in archaeological findings throughout the Ganges–Jamuna Doab region of India, consisting of bronze but more commonly copper.

Akbarnama—written by August 12, 1602—depicts the defeat of Baz Bahadur of Malwa by the Mughal troops, 1561. The Mughals extensively improved metal weapons and armor used by the armies of India.

It was written in the Tarikh-i Firishta (1606–1607) that the envoy of the Mongol ruler Hulegu Khan was presented with a pyrotechnics display upon his arrival in Delhi in 1258 CE. As a part of an embassy to India by Timurid leader Shah Rukh (1405–1447), 'Abd al-Razzaq mentioned naphtha-throwers mounted on elephants and a variety of pyrotechnics put on display. Firearms known as top-o-tufak also existed in the Vijayanagara Empire by as early as 1366 CE. From then on the employment of gunpowder warfare in the region was prevalent, with events such as the siege of Belgaum in 1473 CE by the Sultan Muhammad Shah Bahmani.

In A History of Greek Fire and Gunpowder, James Riddick Partington describes Indian rockets, mines and other means of gunpowder warfare.

The Indian war rockets were formidable weapons before such rockets were used in Europe. They had bamboo rods, a rocket-body lashed to the rod, and iron points. They were directed at the target and fired by lighting the fuse, but the trajectory was rather erratic. The use of mines and counter-mines with explosive charges of gunpowder is mentioned for the times of Akbar and Jahangir.

By the 16th century, Indians were manufacturing a diverse variety of firearms; large guns in particular became visible in Tanjore, Dacca, Bijapur and Murshidabad. Guns made of bronze were recovered from Calicut (1504) and Diu (1533). supplied Europe saltpeter for use in gunpowder warfare during the 17th century. Bengal and Malwa participated in saltpeter production. The Dutch, French, Portuguese and English used Chapra as a center of saltpeter refining.

Hyder Ali, prince of Mysore, developed war rockets with an important change: the use of metal cylinders to contain the combustion powder. Although the hammered soft iron he used was crude, the bursting strength of the container of black powder was much higher than the earlier paper construction. Thus a greater internal pressure was possible, with a resultant greater thrust of the propulsive jet. The rocket body was lashed with leather thongs to a long bamboo stick. Range was perhaps up to three-quarters of a mile (more than a kilometre). Although individually these rockets were not accurate, dispersion error became less important when large numbers were fired rapidly in mass attacks. They were particularly effective against cavalry and were hurled into the air, after lighting, or skimmed along the hard dry ground. Hyder Ali's son, Tippu Sultan, continued to develop and expand the use of rocket weapons, reportedly increasing the number of rocket troops from 1,200 to a corps of 5,000. In battles at Seringapatam in 1792 and 1799 these rockets were used with considerable effect against the British.

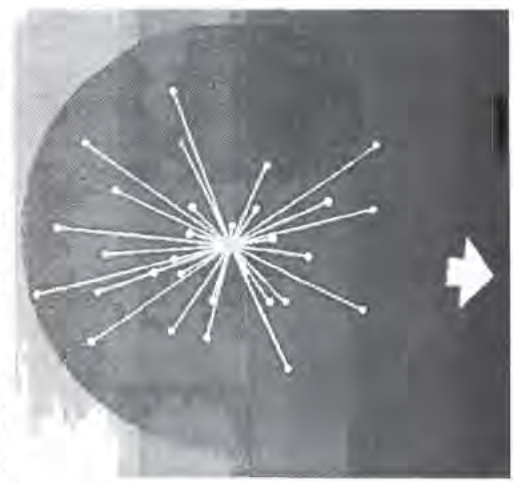
ODISA'S ARCHAEOLOGY AS SOURCE OF HISTORY OF ANCIENT SCIENCES

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In this brief report for the benefit of scholars of History we make a technical jargon less review of 4 of our papers that have fuzzed out history of science from the dated archaeology of India. We nomenclature them as Case No. 1 to 12.

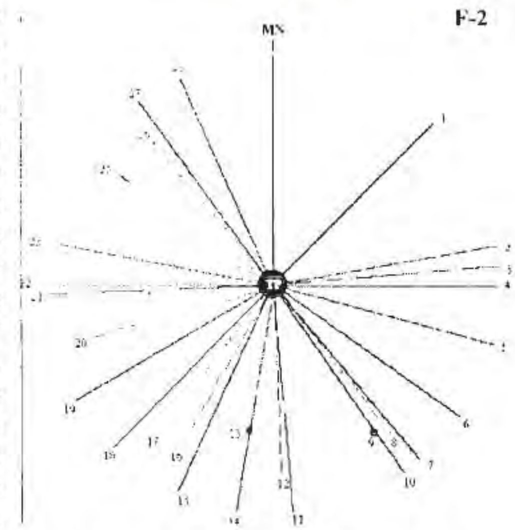
Case No 1

In the Indian Journal of History of Science IJHS [1], we observed "There are scientific reports on astronomical connections of historical monuments in Egypt, UK, Central America, Peru, Polynesia and in the south east Asia [2, 3, 4, 5,6]. But none have been reported from the Indian subcontinent. India is the very geographical zone in which various theistic and atheist schools of thought with all their abundant astronomical facets, flourished. Starting with the Vedic period, celestial observation in India had fulminated into a systematic science in the ÏiddhÁÆt period from c. 5th A.D., onwards. Authorities like Aryabhata [7], Varahamihira [8], Bramhagupta [9], Bhaskar-acharya [10], Satananda [11] and Samanta Chandra Sekhara [12], have left invaluable contributions, including naked eye observations, calculations followed by use of instruments by physicists [13], and positional astronomers [14,15]. On the other side, A.K. Coomarswamy [16], T.A.G. Rao [17] and vary many ASI publications [18] have consistently alluded to an connection between



astronomy and HiÆdÚ iconographs. However, astrologers and astronomers [19] seem not to have given any diligence in the field archaeoastronmy. This created un-bridged gaps. An one-to-one correspondence between dated archaeology and known or established aspects of astronomy was wanting. Having such perspective in mind the Rig Veda [20] on closer examination appears as some sort of a treatise about time in the space and location in the space in relation to diurnal time and direction. It uses arcane phones often with (by present day standards) self infracting present-continuous grammar, in limited diction. It is an abstract, it is about abstracts cum an ode to the cosmos. Besides, a strong tradition of immense influence of astronomy on society by way of elaborate prescription of ideal dates and time for observance of religious and social functions, including for birth , marriage and demise is noted in the Hindu society[21], as a common unifying element. We raised the question 'do the Hindu archaeology indicate any astronomical concepts or astro association ? If Yes, what are the identities of such celestial bodies and their corresponding archaeology ? We then determined that star Betelgeuse has the greatest historical and ÐiddhÁÆtic depth in Indian thought. Betlegeuse is also known as Orion, alpha Orion, KÁlapÚrÚÐa and as RÚdªÁ. The various Vedas mention the names of 27 stars. Stars are known as nakÐatªa which form an important component in Hindu thought, literature, culture and tradition. Elsewhere, 27 nakÐatªas are also noted on Ïiva liÆga [22]. We then identified the stars and on a Star Chart [23] and a Star globe [24] and placed them around star RÚdªa using very precision and sophisticated 3D soft ware IRON CAD [25] as alike reproducing the whole of the (visible part) Cosmos. Each star was given a identification number alongwith its original astronomical colour. We then connected the 26 stars with the central star RÚdªa (Fig.1) in a

F-2



Index -: MN= Magnetic North ; TP= Theodolite position ; Dotted lines point to AMs that were 'Not Visible' from position TP.

radial pattern. Yellow arrow points towards True North. We know that PaªaÐÚrÁm is the RÚdªa aspect of Ïiva. Bhubaneswar is considered as the Temple city of India. It has a near continuous series of significant historical depth, starting with the structure of PaªaÐÚrÁmeÐvara dt. to c.650.A.D. We therefore climbed atop a tall building adjacent to PaªaÐÚrÁmeÐvara, set up a Theodolite (provided by Geography Dept., Utkal University [26] and located important shrines. After offsetting ground adjustment we arrived at Fig.2. TP denotes Theodolite Position and the radiating lines mark the direction of the shrines. We note a suggestive homology between F.-1 & F.2. We then again used the 3D soft ware, with very precise measurements in 3 axis we placed monuments having the traits of the designate star and arrived at Fig.3. We did many things more, the full paper may be viewed.

$$\sin\lambda = \frac{\sin\delta}{\sin\epsilon}$$

It may be borne in mind that that due to wobbling of the earth along its axis, star precesses @ one cycle every 26,500 yrs. Therefore, our TÁªakÁ will break and form every 26,500 yrs. It means that for few thousand years our TÁªakÁ will also be visible in formed state for few thousand years, in disintegration mode for few thousand yrs., and will remain in infracted state for few thousand years. TÁªakÁ is also the most spectacular astronomical gathering of star. Such and similar phenomenon in relation to other astral bodies has been alluded to as the return of the stars in Hindu texts. Such phenomena are bound to influence the human mind, particularly that of the faithful. In the current century (c.2000-2100) TÁªakÁ is in very good formed state (astronomically derived). We again applied mathematics relating to positional astronomy and related multi-disciplinary sciences to see if history and astronomy come closer or not ? We applied the formula where l (lambda) is the longitude, d (delta) is declination and e (epsilon) is inclination of the ecliptic to the equator. c.108 B.C., transpires as the upper date of celestial organization of our TÁªakÁ. Historically, such date coincides with the rise of Emperor Khravela, wane of imperial Magadha and state sponsored Buddhism from KaliÆga. To us, it indicates that around such period re-establishment of Ïiva-liÆga sites may have re-gained currency. Circa 2nd B.C. has also been indicated as the date of the ParaÐÚrÁmeÐvara shrine of Guddimalam, Chitor, Andhra, that enshrines a mono block phallus. The above deduction of time in the space fits well with an important century in Indian history. We do not propose a revisionist theory. Congruence of astronomy and archaeology results in the science of Archaeoastronomy. On global basis, TÁªakÁ (research paper) had broken the Indian silence.

Findings

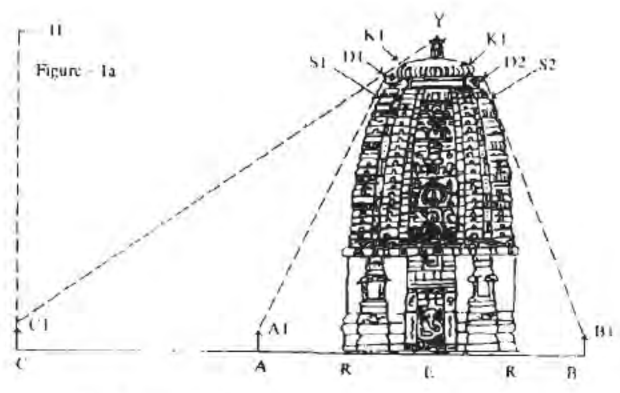
Experiments confirms [i] the radial pattern of TÁrakÁ, [ii] polygonal study as a valid method in archaeoastronomy [iii] scope for astro-mathematic as a valid route [iv] that the ancient temple builders and the faithful conceived of a cascade pattern for stars to locate built heritage [v] the ancients reduced the entire night span on to a ground area of 10 square kms., and located the structures with a one-to-one correspondence with designate stars [vi] TÁrakÁ encompasses the entire night span [vii] Computer Simulation experiment suggests that a visual alignment of RÚdªa and the ecliptic with local latitude of Bhubaneswar ('20). may have been the cause of inspiration [viii] the KÁlapÚªÚÐa MaÆ±ala (Orion constellation) has been copied entirely on the ground [ix] the Orion forms the hub of the TÁrakÁ scheme [ix] the Buddhist archaeological remains do not form a starry pattern [xi] no other civilisation has so far reported as extensive (historically) and expansive (astronomically) a connection as TÁªakÁ.

Case No 2

In the domain of Hindu mathematics, geometric progression was discussed by Mahavira [27]. World wide, mathematics and structures go hand in hand. They presents elements of geometric progression. N.K. Basu [28] referring extensively to locally sourced palm leaf manuscripts and books etched in Nagari and O±iyÁ script, for the first time provided similar geometric progression (fractals) as are employed by Ðthapatis of curvilinear



temples. Citing other palm leaf manuscripts V. Dehejia [29] was the first to schematically indicate geometric fractals in the base plan of curvilinear structures. Using pure mathematics, fractals have been studied in natural cycles, in pyramidal forms and in mechanical engineering [30]. K. Trivedi [31] reported fractals from among major Hindu schools of temple architecture. D. Bhattacharya [32], discovered new aspects of elevation measurement, mathematics, fractals, smooth mobious curves in ancient historical structures. Currently elaborate use of implement and instrument are noted in all elevation measurement and computational exercises. The curvilinear temples are steep structures sans stair case, are unhelpful in generating data



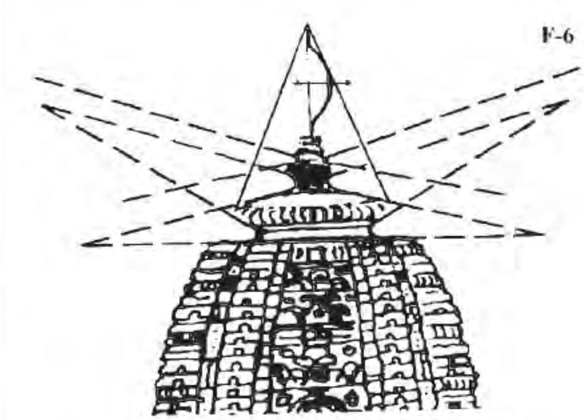
Schematic Representation

about elevation and measures in traditional structures. Temple structures have on them something called BhÚmi añlÁ (Fig.4). Their use, purpose etc., have remained unexplained. F-4 is the bhÚmi añlÁ series of (neighbouring) Muktesvar temple c.9th A.D. Their use, purpose etc., have remained unexplained. Bhattacharya and Naik [33], discussed the History of mathematical and engineering aspects as are embedded in Hindu heritage structures. Fig.5 show how a lay person or young student can calculate the height of a temple.

A temple presents unique angular positions to the beholder when the pinnacle is visualised by naked eye from base. This allows plotting of four exclusive reference points on base off each corner when the line of vision runs from base to top along the central rib of any one of the Ðesa bhÚmi añlÁ - the nose tip of dikpÁla - one rib of the Ka into the Ay i.e. A1, S1, D1, K1, Y and B1, S2, K2, Y are cordant. In spires of post c.9th A.D. only three of the four elements are apparent to the beholder. Since S & D series are available only at the corners, four corner positions are arrived at on base located diagonal to koñi pÁga. The separation between any two such position is the measure of the deÚla's elevation. This methodology holds good for any curvilinear spire of any historical period including Sri Lingaraj temple and Sri Jagannath Temple.

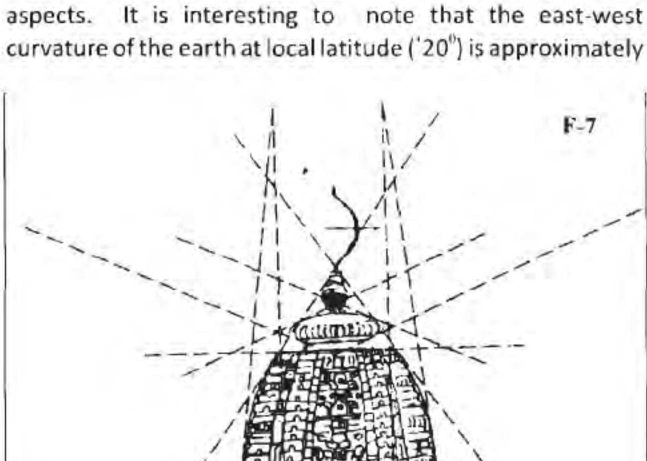
Case No 3

Fig. 6 and 7 give the schematic presentation of the Lingaraja Temple's Cranium (c. 11th A.D.). In brief, in the domain of pure mathematics, mobious surface studies are a mathematician's tool[34]. Mobious architecture is much sought after in Computer Aided Designing of high speed surface, submarine and aero vehicles. Interestingly, our candidate structures are also known as VimÁna (aero vehicle). Architectural outlines of curvilinear and archaeometry generated from it jointly and severally offer



F-6

wide range of smooth curves of various pitches. Curvilinear outline and ÁyÚdha offer surfaces for non cyclic plain arcs of finite and infinitesimal type [35]. Ribs of the amalakÁ ÐilÁ (cranium) and bhÚmi añlÁ (corner rose) offer repetitive arcs. The curvilinear structures are therefore ideal ancient models for study of history of mobious surface related aspects. It is interesting to note that the east-west curvature of the earth at local latitude ('20°) is approximately



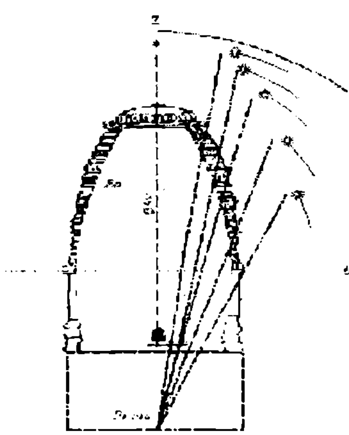
F-7

of the order 15°. This is a natural selection. The curvilinear spire also have a identical angulation. The ribs of the bhÚmi añlÁs also have a separation of the order 15°. We are of the considered view that this results in least resistance to wind and more importantly allows free play of breeze and up-regulates moisture transpiration (from and into the stones). This thwarts erosion and instills longevity. We went on to indicate as to how the 'aÆgÚli' the ancient unit measure stands validated even for making very large and high rise structures. D.Mitra [36] has indicated the prevalence of more than one category of KÁÔhi (scale). We have proven that the present kÁÔhi equals to 16 inches or 24 aÆgÚli taken at mid phalanges. The 16inch kÁÔhi is different from the aÆgÚli (1.04cm) mentioned in astro-mathematical treaties. For his initial discovery Deepak Bhattacharya, was awarded the Gold Medal by the said engineering congress.

Case No. 4

The transliteration of bhÚmi in Sanskrit and in O±iyÁ lingua is 'earth' and as 'base' in geometry. In architecture it means, reading zone or plane. We raised the question what else may the bhÚmi añlÁ (F-4) represent ? Subsequently, in the IJHS, we the author duo [37] have reported the archaeoastronomical relevance of the bhÚmi añlÁ.

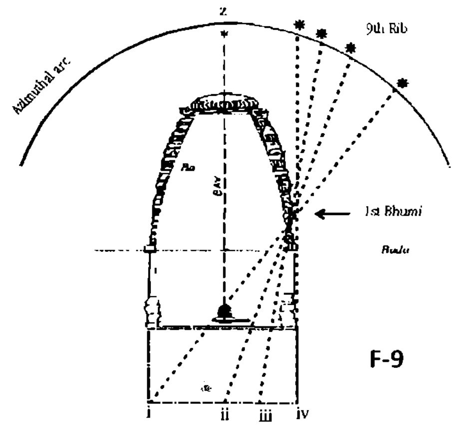
Standard astronomical specification for location of



F-8

celestial bodies use the local vertical hemisphere of the sky as frame of reference for coordinates [38]. The coordinates being (i) altitude and (ii) azimuth. The BhÚmi AñlÁ is used to bring out these two cordinates to trace and track astral bodies. In place of the local hemisphere bhÚmi añlÁ uses the corner hemisphere as frame of reference.

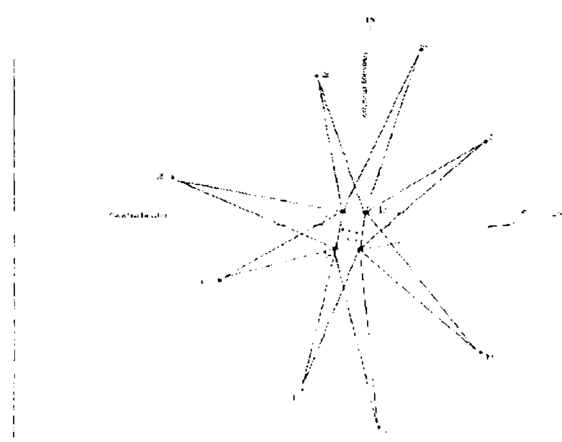
In relation to our Case No. 4, we can use the bhÚmi añlÁs to trace and track star transit. In such case the opaque structure acts as alike a opaque armillary. Fig. 8 gives the user methodology for determining the 'altitude' of one or any number of stars. Fig. 9 gives the user methodology for determining the azimuth of any one or any number of stars



F-9

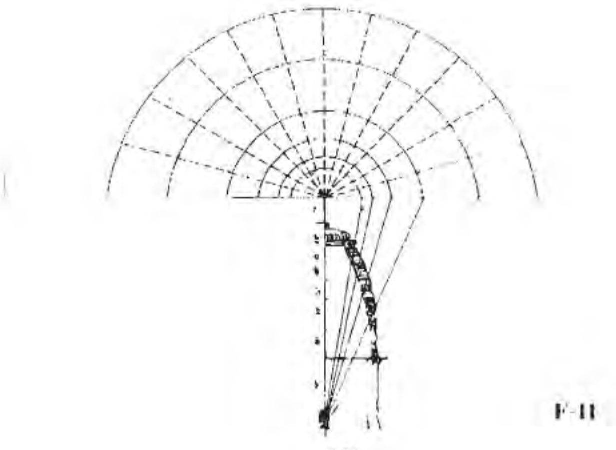
at a time. Any lay person can do this Determination of these two coordinates leads to instantaneous determination of the ground location of the doer/viewer/sailor. This is a ancient Global Positioning System technique. If a person can with such ease determine the altitude and the azimuth, he can then also use a model of the temple to sail in high seas. The bhÚmi añlÁs do that what a sextant does in present day high seas route charting or in the wild.

Case No. 5

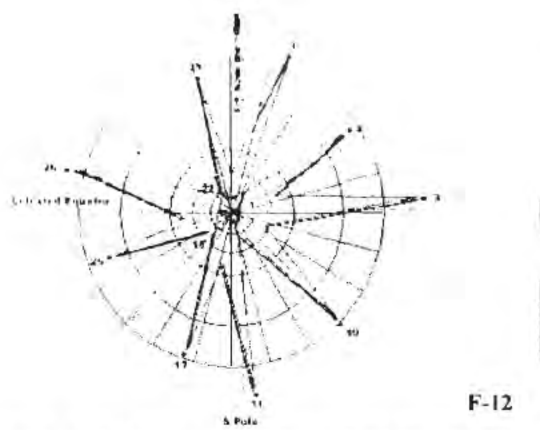


F-10

In relation to our Fig. 1 & 3 if we take the 9 most distant stars from RÚdªÁ (central star) and join them variously to the KÁlapurÚÐa maÆ±ala we arrive at a giant 9 pointed star in the sky[Fig.-10]. We have termed it as NakÐatªa. Now our bhÚmi añlÁs can be used to generate a astrolabe, by completing one half at time [Fig.11] by grid projection method as is used in making geographical projections. The sky nakÐatªa (F.10) can then be placed on Fig. 11 and we arrive at Fig. 12. This makes the composite a mariner's compass look alike. Herman Kulke & Rothermund [39] have opined that, 'in post Harappan periods the KaliÆgiyas have been considered as master mariners and as having best of maritime assets and acumen'. R.C.Majumdar [40], cites noted historians like S. K. Aiyangar, Radha Kumada



F-11



F-12

Mukharjee and others who all have held that 'mastery over the ports of KaliÆga, gave Rajendra Chola well equipped ships and sailors accustomed to voyage in the very regions which he wanted to conquer'. This suggests as to why the ancient kalingiya mariner ruled the high seas. Since our findings provide technical and material corroboration, we were invited to present our discovery in the Indian Science Congress [41].

Case No. 6

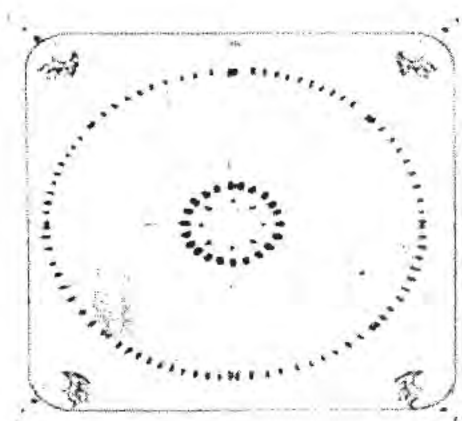
Again, in the IJHS, we [42] have reported few inter societal comparative and evolutionary aspects of the compass co-relating with the archaeoastronomy of NaÔarÁja as are in select Indian dated archaeology.

Case No. 7

Hindus worship an apex form of linga (indicator) and the Brahmins were BªahïaÐÚtªa. D. Bhattacharya [45] has also provided an scientific explanation pertaining to the architectural form of the ÏahaÐraliÆga (millennia indicator) and the BªahïaÐÚtªa (cosmic tenet) that is etched there upon.

Case No. 8

This is the schematic presentation of the cranium of Sri Parasurameswar temple (c.650 A.D.), at Bhubaneswar, Odisa, India - 20-15°N/85-52°E (Fig-13). The central member is known as akas-linga. The term linga means 'indicator'. So akas-linga = sky indicator. The cardinals are marked by jointed ribs with facility for insertion of staff (direction marking). They are marked as 'E', 'W', 'N' & 'S'. The 4 corners are also similarly marked (4+4=8). The octa flag staff positions have an additional rib each. This makes the total (64+8) as 72 ribs. It maps the azimuth at 5°. Thus the khapuri prominently marks out 8 directions and factors the azimuth into an octant scheme at a span of 45°. The vertices of its octagon and the pointers on the domed-circular top are cordant with the 8 flag posts of the cranium, that is below. It is as alike a small dial above a larger dial (as in Chronometers). The 22 mini ribs maps each of the zone of the cranium dial into 3 sub-divisions of equal parts of 15° each. This device can be used to pre locate and track the moon & stars nocturnally and the sun diurnally. It has two dials of variable pinions (one beset into the other), and 8 regional fields (octants). It acts as the radial type Vernier [43].



F-13

F-14

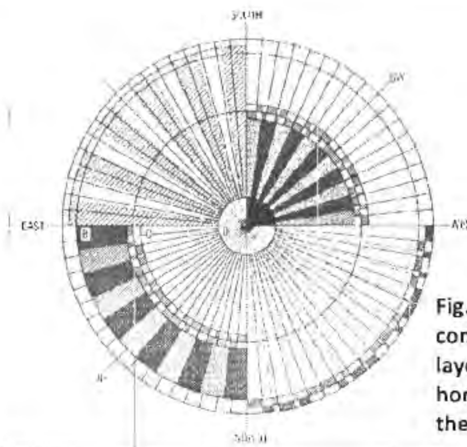


Fig.-14 is the conceptual layout along the horizontal, with the eye at oblique.

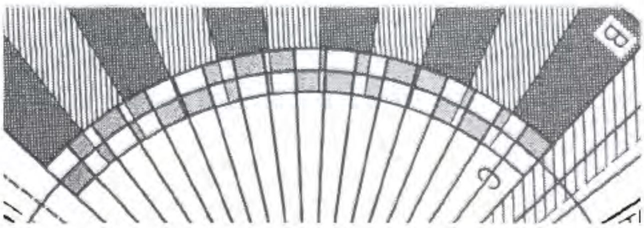


Fig.14a. Vernier aspect as in SW quadrants is enlarged.

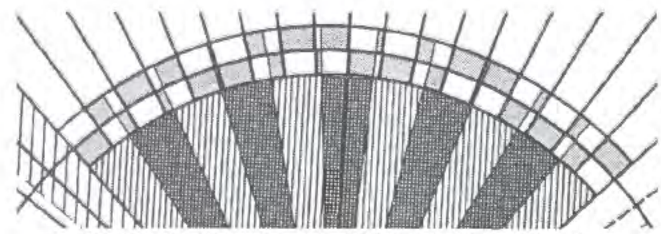


Fig 14c. Vernier aspect as in NW quadrants is enlarged.



Fig.14b. Vernier aspect as in NE quadrants is enlarged.

Case No. 9

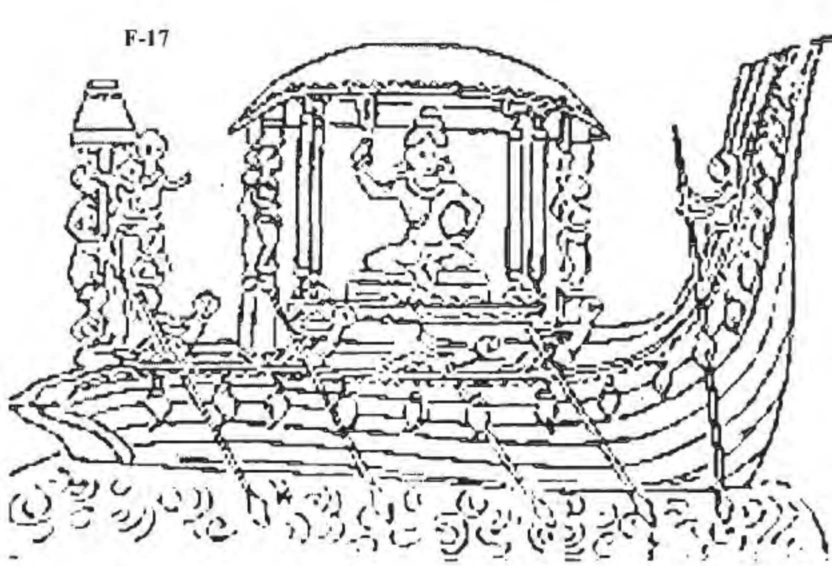
Is that of c. 800-900 A.D. Fig. 14 gives the schematic presentation of the cranium of Sri Siddheswara temple (c.650 A.D.), at Bhubaneswar, Odisa, India - 20·15°N/85·52°E. This is a case of more well developed Vernier. The sectional studies have been rendered in Fig14a to 14c





Fig.15 is that of central member of Fig. 14. It is a Vikhyana Yantra (viewing device). Fig.16 is that Lord Siva's jyana yoga diksa murti (knowledge aspect) alias Sadasiva, in bass relief on the doorway. It is very significant to context. Maritime engineering and direction computing sciences were (more than what it is in the present times) biggest knowledge and hence were associated with the supreme God-head's best of aspect i.e., his knowledge bestowing aspect known as sadasiva (Always the fact). We know science is 'always the fact'.

F-17

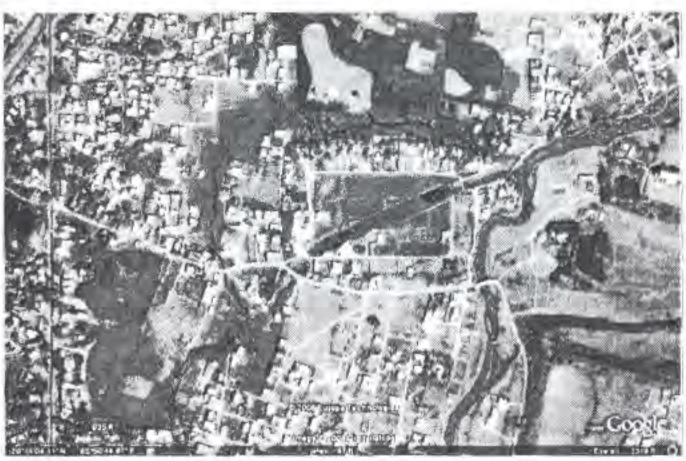


F-18



Case No. 10

Fig. 17 is that of helio centric depiction in the archeology dt. to c.11th A.D., and is atop Sri Brahma's temple, at Bhubaneswar. Has been published by The Asiatic Society (44). Fig.18 is that of the emperor of mighty Kalinga (historical entity) sailing fast forward on a pair of jointed barge; sitting in lalitasana (majestic pose) and conducting Fleet Review of the proverbial Kalingiya Nau Bahara (cleaver & intelligent navy). He alike emperor Caesar has female courtiers on board, too. The artifact is dated to c.12th A.D. With immaculate details it is preserved inside Sri Jagannath Temple (45).



F-19

Case No.11

Fig.19 is that of a inland, sweet water all weather dock. It is located to the NW corner of Sisupal garh fort and is tentatively dated to around c.4th millennia B.C. Fig. 20 is the engineering lay out of the hydraulic structure. It is few times larger than the Lothal dock, Gujarat (46).

Case No. 12

Pertains to rare primary & sources. Deepak Bhattacharya has provided a list of iron stylus scripted rare palm leaf manuscripts pertaining to Mathematics & Astronomy (47); another list of rare palm leaf manuscripts pertaining to astrology (48); another list of rare palm leaf manuscripts pertaining to Health Care sciences including for avian and veterinary groups, and above all, a full book on titled "Indian Ancient Sciences" (Germany) that among others include the rare eco-friendly science of limited /controlled weather modification techniques as in ancient India (49). Irrigation Heritage of India (50) and cyclone resistant rural tenement design heritage and anti-heat wave dwelling design heritage and anti-sun stroke food recipe (51) have been published; so also mathematics & Sri jagannath's iconography & related art form (52); military geo-strategic - few extraordinary concepts (53). So also has been published India's heritage in paddy field soil conservation practices (54). While some

more items of compass and navigation have been studied//reported, are herein excluded for the benefit of terminating this report. An Versatiile Compass (55). However, it is relevant that a sculpture having extraordinary co-relation with Jagatguroo Adi Sankaracharya has also been discussed (56). At last, scholars are urged to visit the works pertaining to how, now, the rural people in the remote are fending self from malaria by adopting Home Grown Technology - "Fight Malaria at Home" (57).

DISCUSSION

The term *KaliÆga* means 'intelligent and cleaver' [58]. It seems, the societies of yore have used a *kaliÆgiya Đaili* to embed scientific heritage either for the learned mind or hide it from the evil eye or to attain either objectives. The panorama of the archaeological remains of India is ultra wide and deep. We think, we have been able to only study and report a minute fraction of only few aspects of science as are embedded in dated and non dated archaeology. In this brief review, we have presented topically a series of discoveries for the benefit of the scholars. In all our original exploratory works we have used physical sciences, experimental, counter validating methods and multi-disciplinary models. We have therefore, herein tried to be very simple and brief. We can present the same via Power Point and Animation for easy understanding.

CONCLUSIONS

Built heritage are almanacs. Indian archaeology is more than a millennia deep and of sub-continent wide. It is a veritable store house of ancient sciences awaiting and beckoning the able and the indulgent. Multi-disciplinary effort on a larger scale in a sustained manner is warranted to fuzz out the embedded scientific matters. We have not been able also to touch the Islamic component (we have gathered data). The exercise among others, constitutes History of Science. It civilizes; humanizes and humbles.

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PURI-KONARKA HERITAGE SITES ON ODISHA COAST ON BAY OF BENGAL, EASTERN INDIA: GEOLOGICAL BACKGROUND AND VULNERABILITY TO NATURAL HAZARDS

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INTRODUCTION

Two famous cultural / religious heritage sites one at Puri (12th century A.D.) and the other at Konarka (13th century A.D.) are located at a distance of ca. 35 km from each other on the Bay of Bengal coast in Odisha State, eastern India (Fig. 1). They lie ca. 3 km away from the present seashore. The temples are huge archaeological edifices of superb sculpture and workmanship that bewilder people who come to visit these sites in different times of the year. Puri temple is celebrated for worship of Lord Jagannath while Konarka Temple was well known for Sun worship. Puri Jagannath temple rises to a height of 65 m. while the existing portion of the Konarka temple ('Mukhasala'/porch) is about 39 m high. The original height of the main Konarka temple / sanctuary must have been more than 61 m. Konarka temple has been ruined in the passage of time. The main temple / sanctuary is demolished and now only the entrance to the main temple known as 'Jagamohan' / 'Mukhasala' / porch leading to *sanctum sanctorum* exists. After wear and tear whatever now remains of the Sun Temple of Konarka baffle the minds of visitors when they observe its exquisite and fabulous sculpture and ponder over the way the temple was constructed on the seashore some 800 years back. This paper presents informations on the geological background of the sites, vulnerability to natural hazards and measures for protection of the coastal belt for the safe preservation of the cultural / religious heritage sites. Konarka Temple bears the insignia as a UNESCO World Heritage Site.

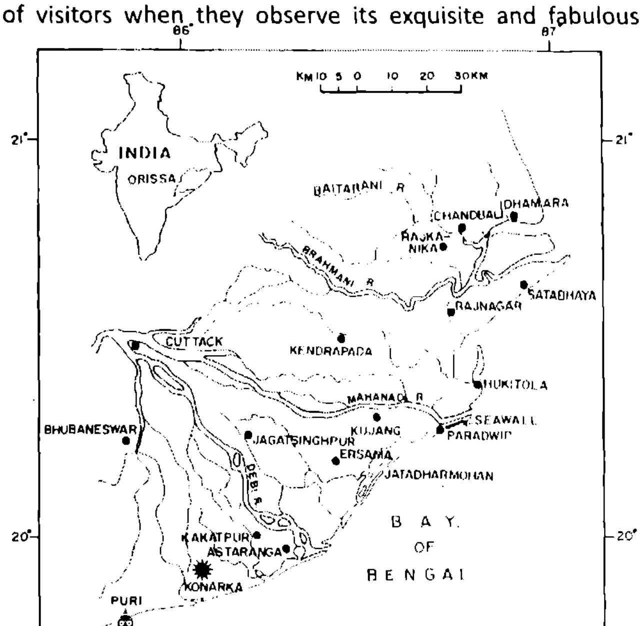


Fig. 1 Odisha Coast showing cultural / religious heritage sites at Puri and Konarka in the Mahanadi River delta.

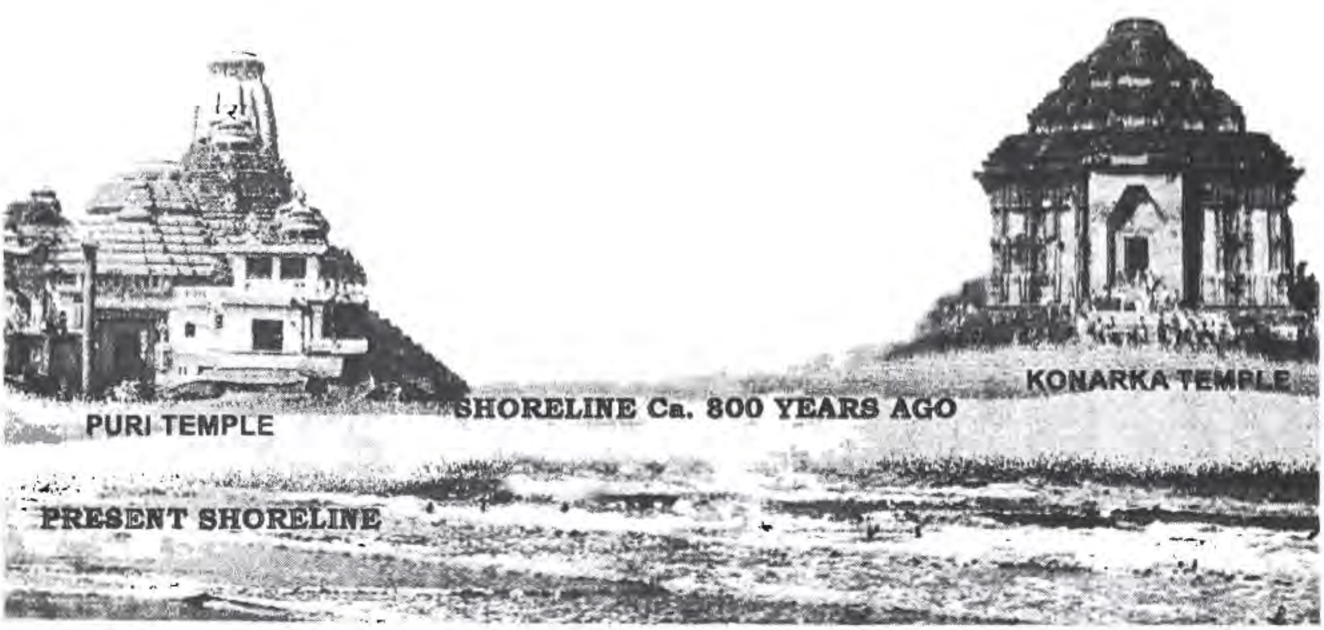
CLIMATIC AND GEOLOGICAL BACKGROUND :

The coastal tract between Puri and Konarka comes under the Mahanadi river delta plain between 85° 40′ : 86°45′E and 19°40′ : 20°35′N. The Mahanadi river drains a catchment area of 1.42×10^5 km^2 and after traversing a long distance of ca.851 km forms the delta head at Naraj ca. 10 Km west of Cuttack where the river branches off and in the delta plain several distributary channels are formed before the river debouches into the Bay of Bengal. The climate is hot, humid and tropical. Annual average rain fall is ca.1572 mm out of which 70% is precipitated during the southwest monsoonal months between mid.June to mid.October.

The coastal region is manifested by several Holocene geomorphic landforms like river channels, flood plains, river meanders, beach ridges, swales, sand dunes, beach, spits, barrier-islands, bars, tidal channels, tidal flats, managrove swamps and estuarine river mouths.

The coastal Holocene sediment cover is bordered by lateritic uplands about 100 km away from the coast. The hinterland in large part is a Pre-cambrian terrain where the Eastern Ghats Hill Ranges stand prominent. The Proterozoic Eastern Ghats Mobile Belt is a northeast-southwest trending granulite belt. It is a belt of high grade metamorphism evidenced by garnet – sillimanite association. Garnet-biotite gneisses and augen-gneisses also occur. Typical rock type khondalite is a metamorphic rock of granulite facies characterized by minerals like garnet, sillimanite, plagioclase feldspars and quartz associated with graphite. Manganese–bearing mineral kodurite and aluminium –bearing bauxite may also be occurring. The rock may be exhibiting schistose / gneissose texture / structure. The khondalite is associated with charnockite which is a

hypersthene-bearing granite showing gneissose structure. Anorthosites, amphibolites, basic/ultra basic igneous (metamorphosed varyingly) rocks calc-alkaline and alkaline rocks are encountered in the Eastern Ghats Granulite Belt. The Eastern Ghats Mobile Belt is correlated with 1100 Ma-old Greenville Province of North America and is presumably juxtaposed with the Enderby land of Antarctica (Chetty, 1998). High-grade Eastern Ghats Precambrian Mobile Belt adjoins the low-grade Archaean cratonic terrains to the west and north. Eastern Ghats Orogeny was followed by Mahanadi Orogeny. Vertical reactivation along several regional faults have produced some horst and graben structures like Eastern Ghat horst in the centre flanked by West Odisha Graben and Coastal Graben. It is thought that the intersection of Mahanadi graben and coastal graben has been the site of Mahanadi delta development (Mahalik, 1998). There are a few tectonic depressions and ridges in the coastal and off-shore area. (Mishra, 1984; Kaila et al., 1987; Narula et al., 2000). Puri-Konarka coastal tract is delineated as Puri-Konarka Depression which is filled by ca. 2400 m of Quaternary siliciclastic sediments with continued subsidence of the tectonic Depression affected by growth faults. Geological informations suggest Mahanadi River delta progradation during the Holocene (especially within last 6000 years) and it is thought that the shoreline has regressed 2–3 km during the last 900 years (Mohanti, 1990, 2000b) suggesting that the temples were built close to the seashore (Fig. 2). The boldness of the then architects to build these massive, high archaeological edifices close to a vulnerable seashore battered by winds and waves which could mount high during severe cyclones / supercyclones with accompanied high storm surge, indeed, baffles the mind and raises several questions as to why these sites on a desolate, dreary sandy shore were at all selected for temple construction and the way the temples were constructed to such heights. It is amazing ! We believe that the ancient architects had a good knowledge of the subsurface conditions, rock types for temple construction, seismic nature of the coastal tract, meteorological conditions and technical know-how / engineering skill in building the temples (Mohanti, 2004a). It may, however be mentioned that the metamorphic rock khondalite was available in plenty and was amenable for carving images. The sculptors were tempted to use this rock for chiselling sculpture in both Puri and Konarka temples. However, they perhaps have lost sight of the vulnerability of khondalite to weathering. Khondalite has feldspar mineral which alters to kaolinite and in the process garnets stand out prominently and takes spongy appearance of iron oxides / hydroxides. Presently, the sculpture of the temples have sustained the weathering effects and as a result of which many images and parts of the sculpture are damaged. Both the temples are under the control of the Archaeological Survey of India who should take appropriate steps for conservation, repair and maintenance of the temples and save the edifices from further deterioration.



. 2Conceptual perspective of Puri and Konarka temples on a regressive shoreline.

Plutonic to hypabyssal basic, ultrabasic and acid intrusives of various forms and sizes of Pre-cambrian age characterize shield areas in Odisha and adjacent Singhbhum region in Eastern India. Mafic and ultramafic rocks are distributed almost all along the eastern, southeastern, southern and southwestern fringe of Singhbhum – Odisha Craton. The ultrabasics are varyingly altered to serpentine, talc and tremolite producing greenish serpentinite and soapstone–steatite associations. Serpentinized rocks show weak to strong foliation. There also occur basic dykes of pyroxenite, dolerite and gabbro. Basic–ultrabasic suite of rocks occur in a girdle from Nilgiri area in the Balasore District in the east through Baula – Nuasahi and Sukinda upto Deogarh in the west (Mukherjee et al., 1998).

Some Lower and Upper Gondwana sandstones associated with siltstones / shales (Lower Permian – Lower Cretaceous) are found in isolated outcrops near the delta head of the Mahanadi river. Gondwana sandstones are sporadically lateritized.

Fractures and lineaments are observed in the coastal tract. (Bharali et al., 1991; p. 43, fig. 7).

GEO-ARCHAEOLOGY :

The archaeology/geoarchaeometry was guided by the geo-materials used in the temple construction. Rock types used in temple construction and chiselling the sculpture were principally khondalites and metabasics / ultrabasics. Some amount of laterite was also used in basement part (Mitra, 1998), These rock types were available in the hinterland of the coast and were transported to the temple sites situated close to estuaries by rafts /barges principally in the Mahanadi river system and its distributary channels in the coastal deltaic tract where some of the channels have presently vanished during conversion of the deltaic tract to agricultural fields ; yet, the local names like 'Patharabhasa Nai' (stone-carrying rivers) of parts of the present defunct channels suggest that the channels were used in former times (ca. 800 years ago) for transporting huge slabs of rock to the river mouth site, nearby which the temple construction work had started. Chandrabhãgã estuary which is now silted up and located close to Konarka temple probably formed a main channel of rock slab transport. Bhargavi, Kushabhadra, Prachi and Kadua river channels of the Mahanadi River distributary system facilitated transport. While khondalite was the principal rock type used in the bulk construction of both Puri and Konarka temples, geometry of the architectural motif and large number of images carved out on the temple walls (Figs. 3, 4, 5, 6); the metabasics/altered ultrabasics (serpentinite–steatite) have been subordinately used in finer chiselling of some images as well as for enhancing the aesthetic appeal in parts of the temple motif (Figs. 7, 8). These metabasics / altered ultrabsics have been apparently termed as 'Chlorite slabs'/'Chlorite platforms' by archaeologists (Mitra, 1998). Use of iron beams (Fig. 9), clamps and some copper construction in the temples suggest knowledge of metallurgy in ancient times. The main Konraka temple-complex consists of a sanctuary, its attached front 'Mukhasala'/porch and an isolated pillared hall / Bhogamandapa. Sanctuary and porch form a whole architectural unit designed as a huge chariot conceived as a celestial chariot of Sun-God believed to course across the sky driven by seven galloping horses and fitted with twelve pairs of wheels which reveals itself as a bewildering conception immortalized in rock sculpture by the then sculptors by stroke of their hammer and chisel to capture the far-stretching imagination of the present visitors to the grand monument of Konarka temple. It took 12 years time to build the huge Sun temple where 1200 architects had worked under the patronage of King Langula Narasimha Dev as the legend goes.

The sanctuary / main temple and probably the porch were fitted with a pot-like attachment at its top known as the 'Kalaśa' made of copper. An iron rod called chumbaka-luhā-dhāranā ('magnetic-iron rod') most probably passed through the 'Kalasa' (Mitra, 1998, p. 10). 'Kalaśa' and the lotus-finial 'Padma-dhvaja' got dislodged and were probably carried away by Muslim invaders. The 'magnetic-iron rod' which was still in position was removed by the crew of a ship which passed along the Konarka coast as the magnetic-rod used to draw ashore sea-faring vessels along this coastal stretch (Mitra, 1998, p.10).



Fig. 3Puri temple with a tall pillar *"Arunastambha"* standing in front of it.



Fig. 4Konarka Sun temple

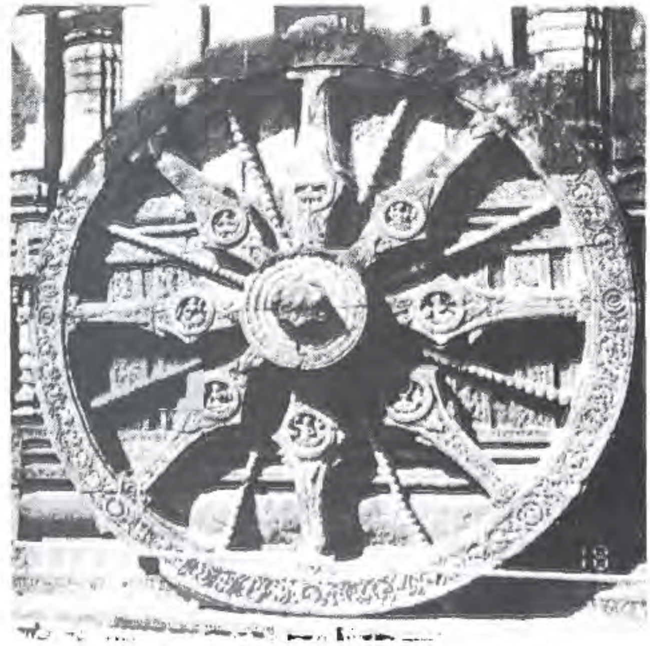


Fig. 5One of the wheels of the Konarka temple with fine sculpture on Khondalite rock.



Fig. 6A platform for offerings to the deity *"Bhogamandapa"* built in front of the Konarka temple showing fine sculpture on Khondalite rock.



Fig. 7An image of Sun God with other associated sacred figures carved out of meta basic / ultrabasic rock in Konarka temple.

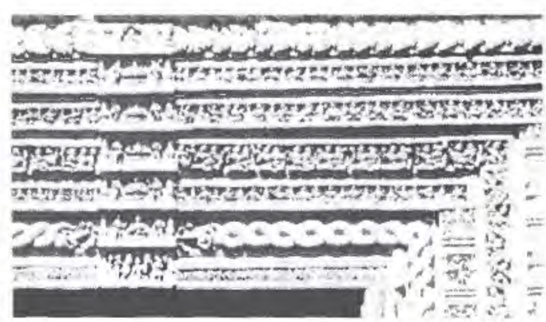


Fig. 8Fine sculpture chiselled on metabasic / ultrabasic rock in the upper part of the main entrance / porch of the Konarka temple.

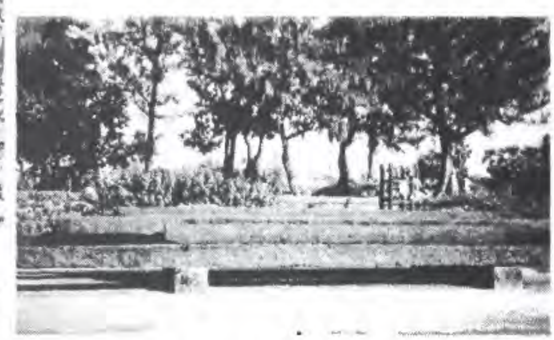


Fig. 9 Iron beams used in the Konarka temple.

Due to poor maintenance and several other natural factors and human interferences parts of Konarka temple particularly the sanctuary / main temple collapsed in the passage of time. A rock pillar known as 'Aruna Stambha' or 'Pillar of Charioteer of Sun' has been removed from Konarka temple and erected in front of Jagannath temple at Puri (see Fig. 3) in the 18th century. This pillar is of metabasic rock and is termed as a 'chlorite pillar' (Mitra, 1998). The pillar ca. 10m high may monitor sea-level rise during supercyclonic storm surge intrusion inland and make people alert about the safety of the inner precincts of the Puri temple. Archaeological monuments in the nearshore region may be used as Global Sea Level Monitor (Mohanti, 2000b). Both Puri and existing part of Konarka temples may have served as important landmarks on the seashore guiding sea-faring vessels in the ancient times having a palaeogeographic significance. Konarka temple was called as 'Black Pagoda' by the navigators passing through offshore Konarka because of its pagoda–like shape. These temples must have been very useful to navigators in times of storm conditions for availing proper rescue measures on time. As regards the construction of the temples is concerned, it seems both the temples were raised with gradual building of rock slabs to certain height and then covering it with sands to make a platform for raising further height and then piling sands again over it and so on till the final height of the temple was attained. Slabs of rocks might have been taken on ramps facilitated by labourers and wooden rollers. Pulleys and wooden wheels may have also been used for lifting heavy rock slabs to higher elevations. Hundreds of years back this method may have been adopted by the then architects as machineries were not available then for lifting rocks to higher levels. Still it is possible, architects used ladders and bamboo intertied platforms which could have facilitated to take rocks to higher levels of the temple.

NATURAL HAZRDS :

Odisha coast with cultural / religious heritage sites is vulnerable to natural hazards like cyclones/supercyclone, monsoonal floods, mild earthquakes, mild tsunami waves accompanied by earth tremors which are briefly highlighted.

Cyclone / Supercyclone

Seasonal and episodic coastal storms/cyclones frequently occur on the east coast of India on the Bay of Bengal. Depressions arise in the Bay of Bengal leading to cyclones during the pre-monsoon months (May-June) and post-monsoon months (October – November). During prevalence of low pressure / depression, rains lash the coast and wind speed ranges to about 60 km / hr. When the depression is accentuated to a tropical storm, wind speed mounts to 87 km/hr and in a severe tropical storm it enhances to 116 km/hr. Storm surge of 6-7m high may ingress parts of the coastal tract during severe cyclone. If heavy rainfall during depression/cyclone continues for a week, then there is large-scale inundation of the low-lying areas with consequent stagnation of water. During the days of monsoonal heavy rainfall about 1m or more of rainwater accumulates in the precincts of the Konarka temple. Such water logging for a longer period is obviously detrimental to the foundation site of the temple.

On October 29,1999 a Supercyclone named as 'KALINGA' (Mohanti, 2000a), unprecedented in the century, devastated the coast enormously when wind speed mounting upto 220-300 km/hr battered the coast for over 36 hours specially between Konarka and Paradwip. The long continued devastation was due to development of an anticyclone above 300 hectapascal (hpa) at 9.5 km above MSL in the upper atmosphere which seems to have arrested the movement of the supercyclonic storm. The stagnation of the meteorological system for a longer period, brought about rampant destruction on the coast. Supercyclone 'KALINGA' records one of the largest cyclonic disasters of the world. Storm surge rose upto 10-12m high inundating parts of the coastal tract upto a distance of 15-25km. The intrusion of saline water was facilitated by estuaries, connected to ramifying tidal channels/creeks in the lower deltaic reaches of the Mahanadi river. Large trees were grounded destroying houses, many other structures and communication system. The casurina plantation near Konarka seashore was severely damaged. The two famous temples discussed herein were miraculously saved in this unprecedented disaster.

Floods

During the monsoonal months (Southwest monsoon between mid. June to mid. October) the rivers in the delta plain are flooded when there is heavy precipitation in the catchment area of the Mahanadi river. Water discharge of 17,150 cumsecs initiates flood in the Mahanadi river. Episodically high floods may occur more than once during one monsoonal season. Damaging floods pass through the river system when water discharge swells to 28,580 cumsecs. Unprecedented floods rising to 44,749 cumsecs have passed through the Mahanadi river delta head at Naraj during two days on August 31 and September 1, 1982 causing great havoc in the lower deltaic coastal tract of the Mahanadi river (Mohanti, 1990). The distributary system flooded and devastated parts of the coastal belt. Flood water stagnated for several days isolating villages and disconnecting road communication. In July 2001 and August 2003 high floods passed in the Mahanadi system when water discharge rose to about 40,000 cumsecs (Mohanti and Swain, 2005). There were high floods in 2008 and 2011 monsoon season. The high floods threaten the sites of several historical temples and heritage sites on the coast.

Earthquakes and Tsunami

Mild earth tremors occur at times in the coastal region as well as in the hinterland area. Historical seismicity records indicate activity along the coastal belt which is a part of the Kakinda-Midnapur Seismic Zone. Present day seismic activity is related to activity along Gondwana Basin Boundary faults and those associated with continent oceanic crust transition zone in the Bay of Bengal (Narula et al., 2000). In the past, few submarine earthquakes have had their epicenters in the Bay of Bengal. One important earthquake originated in the Bay of Bengal on the 31st December 1881 which shook a huge area including Lower Burma, Arakan, Lower Bengal, Orissa, Southern India and Srilanka (Memoirs, Geological Survey of India, volume 35, pt. 3, 3rd reprint 2003). Some aftershocks of earthquakes occurring in Andaman-Nicobar Islands might cause feeble tremors on the east coast of India as recently happened in the tsunami disaster of December 26, 2004. Tsunami waves had disastrous impact on the Southern Indian coast. It had mildly affected the northeastern coast of India.

Sea-Level Rise

Neotectonic changes in the coastal tract may cause coastal subsidence in the Mahanadi deltaic region controlled by active faults. So combined fault-controlled subsidence, compactional subsidence and perhaps eustatic effects may effect sea-level rise on the Mahanadi deltaic coast (Mohanti, 1990). Sea-Level rise, which is presently regarded as a probable consequence of enhanced global temperature due to increased concentration of CO_2 and other green house gases in the atmosphere is expected to accelerate two-to five-fold over the next 100 years. Present estimates based on a few model studies indicate a mean increase in sea-level of 45-51cm by 2100 (Burkett, 2001). Coastal advance and retreat will depend on the critical factor of sediment supply. Due to increased anthropogenic interferences resulting in deforestation, sand excavations and hauling of sands from the shoreface, building of dams and barrages on Mahanadi river, sediment transport to shoreface is getting arrested. Reduced sediment supply will promote shore erosion (Mohanti, 2011a) which will be further enhanced by sea-level rise. This will endanger the coast and its heritage sites.

COASTAL PROTECTION

Global warming natural hazards, sea-level rise and unscrupulous anthropogenic activities are impacting the coast. Heritage sites on Odisha coast need to be protected as this coast is vulnerable to natural hazards. The suggested measures include :

1. Plantation of dense casurinas upto 2 – 3 km from the seashore as a girdle of shelter belt plantation to protect the coast from the ravages of storms / cyclones / supercyclone.
2. Mangroves should cover near estuarine and tidal channel margin. Mangroves act as a buffering zone against onslaught of cyclones. Degeneration of mangroves on Odisha coast is alarming and needs urgent attention (Mohanti, 2000c).
3. Coastal sand dunes must be allowed to develop along the coast and must be protected. Vegetation adopting to dune ecology must be favoured to grow which could stabilize sand. Construction of sand fences may be planned in the shore region and barrier-islands (Savage and Woodhouse Jr., 1996). The dunes in the shore region should function as a barrier against storm surge invasion towards inland region. Conservation of sand dunes must be given priority consideration in the coastal protection strategies (Mascarenhas, 1998, 2002).

Coastal erosion is marked on several stretches on Odisha coast (Mohanti, 2009, 2011b). Erosion has been marked at Puri and Konarka beach (Fig. 10). To combat beach erosion geosynthetic tubes may be applied. Artificial beach nourishment and other engineering measures may be evaluated.



Fig. 10 Sand Bags are piled up to prevent erosion on Puri beach.

1. Anthropogenic activities in removing coastal sands, cutting down casurina plantations, mangroves and other forests must be strictly controlled by implementation of strong administrative and legal measures. Coasts act as natural buffer protection. When human interferences get into the process, coastal physical and storm processes turn into natural hazards culminating in catastrophic disasters. Impacts of natural hazards are obviously amplified by human alterations of the coastal environment (Mascarenhas, 2000, 2004; Mohanti, 2004b).
2. Community awareness and educational programmes must be implemented for an integrated management of coast for the protection of cultural heritage sites.
3. Coastal Regulation Zone (CRZ) of Govt. of India as notified in 2011 should strictly be adhered to.

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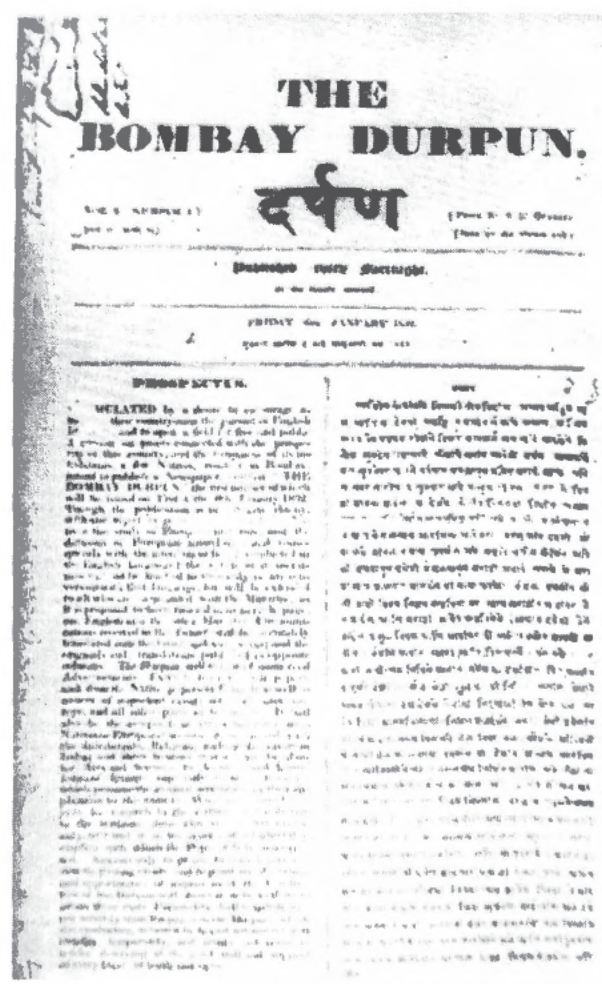
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HISTORY OF SCIENCE WRITING IN MARATHI LANGUAGE DURING PAST 180 YEARS.

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British rule started in 1818 in India when they took over from Peshawas in Pune and unfurled union jack. Mount Stewart Elphinston was the head of the rule and he decided to impart modern knowledge to people of Maharashtra in their mother tongue ie. in Marathi language. Elphinston established Bombay Native Education Society and George Jarvis was appointed its secretary. Through this society, they encouraged scholars of Marathi language to write or translate standard books on various topics of public interest in Marathi language. The list of desirable subjects published by George Jarvis included Mathematics, Astronomy, Physics, Chemistry and Medicine. Geography and Archeology were not included in science then. Archeology was included as, `Antiquities of ancient India`. George Jarvis, Major Kandy and John McLenon were helped by Hari keshavji (Pathare), Jagannath Shastri (Kramavant) and many others. Jagannath Shastri prepared two volumes of Marathi dictionary, which included many scientific terms. George Jarvis prepared books in Marathi on Algebra, Geometry and few other science subjects. The first medical book written by John McLenon was, `Audhadh Kalpavidhi (Preparations of Medicines).`In 1832 a book titled, `Bhugol and Khagol vishayak Samvad (Dialogue about Geography and Astronomy).`At the same time translation of a book, `Mrs. Marsettes conversation on Physics`, `Conversion on Chemistry` `Siddha Rasayan Shastra vishayak Samvad (Dialogue on Medicines)`,`Siddha Padartha Vidnyan vishayak Samvad (Dialogue on Physics) came out in market and this was the beginning of popular science dissemination. In 1857,translation of `Beauty of Heavens` was printed along

FIRST ANGLO-VERNACULAR NEWSPAPER IN WESTERN INDI[A]
पश्चिम हिंदुस्थानांतील पहिलें आंग्ल-देशभाषीय वर्तमानपत्र



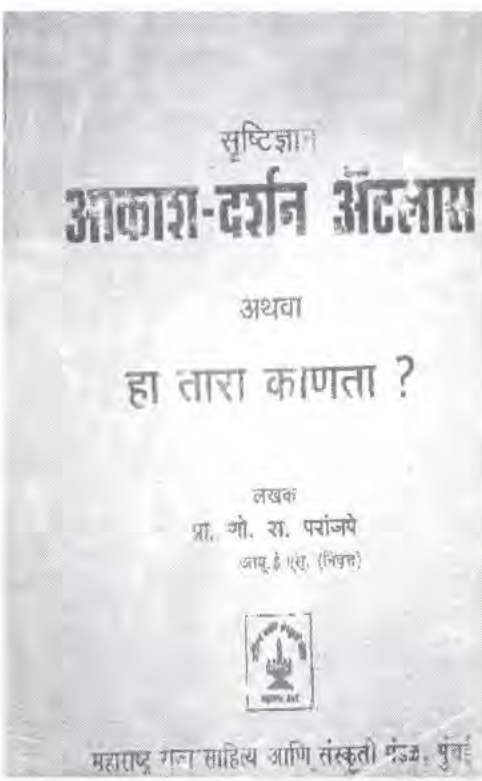
THE BOMBAY DURPUN.
दर्पण

In 1857 Britishers established four universities in India, namely at Mumbai (Bombay),Chennai (Madras),Kolkata (Calcutta) and Punjab. Britishers brought printed news papers, magazines, railway, telegraphs etc in India. The graduates coming out from the then Bombay University started writing in Marathi language, informing people about modern science. It included agriculture, science, technology, engineering, water supply, curing the diseases and so on. The first press was started by Mr. Ganapat krishnaji Patil at Alibaug in dist. Raigad of Maharashtra state in 1831.The first bilingual (Marathi and English) news paper was started by Prof. Balshastri Jambhekar, named, `Darpan (Mirror). Later on Balshastri Jambhekar started a monthly, named, `Digdarshan` in 1837 in which predominately science articles were published. Balshastri Jambhekar was professor of Mathematics at Wilson College, Mumbai and became head of the department at the age of 35 years, when his British Head fell sick. It was Balshastri Jambhekar, who coined Marathi names to all the 12 zodiac signs and 27 constellations, which are being used even today after 170

years. Social reformers like Prof. Gopal Ganesh Agarkar, who professed to study the nature and conquer it for the progress of society, Prof.Dhondo Keshav karve, who started school for widowed women, Mahatma Jyotiba Phule and his wife Savitribai Phule, who started schools for women. Once women started learning, automatically an atmosphere of education started spreading, the thought of scientific temper grew up and science literature in popular way increased. After Digdarshan number of Marathi magazines started, few of them were Marathi Dnyanprasarak, Keral Kokil, Chitramay Jagat, Vividha Dnyanvistar, Balankur, Dnyanoday, Shilpakalavidnyan, Shetakari, Rashtrabodh,Lokashikshan,Marathi Shikshak and many more. At least 75 of them could be counted. Marathi Vidnyan Parishad published an anthology of science in Marathi during 1830-1950 in two volumes jointly with Vigyan Prasar, New Delhi, in which these 75 magazines have been recorded.

In 19th century, total number of books published were 4719 in Marathi in which 233 books were on popular science (about 5 %),during next 37 years, total number of books published were 26,569 and on popular science were 729 (about 2.7%).A survey of scientific articles during 1857 to 1860 was available and it showed that out of total number of articles published, about 3.75% articles were on popular science. However, mostly they were translated from English, whereas during 1912 to 14 the figure increased to 4.5%.During 1950 to 2000,2161 books on science and 1755 books on health and medicine were published in Marathi. These are books on popular science. Besides these,187 books on science and 124 books on health and medicine were translated from English into Marathi, again on popular science. Thus one can say safely that during past 180 years about 5000 books were published on popular science. This figure is very much comparable to books on popular science getting published in many foreign countries except in English and Russian languages.

Upayukta Dnyan Prasarak Sabha (Useful knowledge disseminating institute) was started on lines with Royal Philosophical Society. It ran for 17 months, organized lectures and discussions at Elphinston College, Mumbai. In this institute, scholars were invited to deliver the talks. These talks then were printed in Dnyan Prasarak magazine.The subject covered then were,botony, agriculture, chemistry, zoology, geography, geology, general science, health and medicine, biographies of scientists, physics, astronomy and meteorology. Total number of articles published on science were 183 (36%) out of total number of articles 493 in this magazine. In 1928,Prof.G.R.Paranjape and his colleagues started magazine, `Srushtidnyan` from Pune and is running continuously for past 83 years and in Aug,2011 Srushtidnyan published their 1000th issue. During 1928-95,Srushtidnyan published 6360 articles on popular science. There are subject wise magazines in Marathi on agriculture, ayurved,astronomy,health,homeopathy,allopathy,water management and so on.



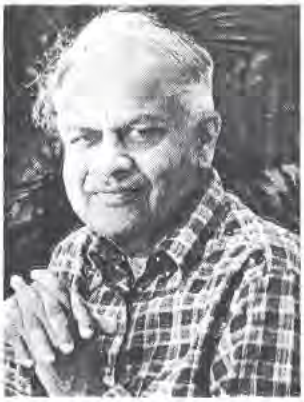




News papers like Kesari completed 128 years, Sakal completed 78 years. Kesari, Sakal, Lokasatta, Maharashtra Times and many more dailies are publishing popular science articles, specially during past 25 years. Maharashtra Times was publishing a weekly science supplement for 15 years from 1983.Every news paper publishes at least 3-4 articles every week on popular science. There is a daily named,`Agro-1`specially for agriculture and it has a very good circulation. Many books on popular science get published in Marathi and many professors, scientists, engineers and other professionals write such books. There is an encouragement from Government of Maharashtra by way of awards to the best popular science books for adults, children and so on. Maharashtra Government have a cell named,`Rajiv Gandhi Science and Technology Commission` which partly takes up the programmes of popularizing science, like National Science Day and so on.

On All India Radio, there was Science cell from 1976 till 1990 at Mumbai station. Although, that cell is no more existing, programmes on science like talks, quiz, sky gazing. story telling, interviews, discussions on science subjects keep going on.Television channels do not broadcast as many science programmes as much radio does.

There are many institutions disseminating science in Maharashtra. Jyotirvidya Parishad, Marathi Vidnyan Parishad, Lokavidnyan Sanghatana, Kanad, Khagol Mandal, Amature Astronomer`s clubs, Nehru Science Centre, Nehru Planetarium, Homi Bhabha Centre for Science Education, IUCAA(Pune),Mahatma Phule Museum (Pune),Raman Science Centre (Nagpur),Kalpana Chawala Science Centre (Karad) are few amongst them. Marathi Vidnyan Parishad (MVP) got established in 1966 and have 68 branches in the state of Maharashtra and 4 outside the state.MVP organizes variety of programmes for the entire cross section of the society, prominent among them are gender education, terrace gardening by using house hold bio-degradable waste, sky gazing, solar cooker and solar water heater making workshops, concept development course for school children and so on.MVP started science fiction writing competitions in 1970 and is continued for past 40 years and science fiction writers like Prof .J.V.Narlikar, Dr. Bal Phondke are the products of this effort.MVP holds annual conferences on popular science topics for past 46 years. It publishes a science monthly for past 45 years and have published many useful books and encyclopedias in Marathi.



Dr. Jayant Narlikar

In Maharashtra, well known scientists like Prof .B.M.Udgaonkar, Prof. J.V.Narlikar, Dr. Vasant Gowariker, Dr. Anil kakodkar, Dr. Vijay Bhatkar, Dr. Kamala Sohonie, Dr. kamal Ranadive, Dr. R.A.Mashelkar, Dr. Bal Phondke, Prof. M.M.Sharma, Prof. Madhav Gadgil, Dr. Madhav Chitale, Dr. V.H.Sardesai, Dr. V.N.Shrikhande, Dr. Shankar Gowariker, Mr. Pramod Kale,Prof.V.G.Bhide are /were delivering lectures in schools, colleges and in public on popular science, and also writing articles in news papers. Prof. V.G.Bhide started an institution, `Exploratory in Pune to create curiosity among children. He created a movement of children science congress. Homi Bhabha Centre for science Education is running science Olympiads for more than past 20 years to create liking of science among youth. Marathi Vidnyan Parishad organizes lectures on, `why students should go for science research as profession`.

In celestial events like total solar eclips, march of venus, mars, meteor shower, comets, large number of programmes get organized throughout the state.

Every year, one or the other institute/university/college organize a seminar lasting for a day or two on popularizing science on a topic A or B, inviting many researchers and popular science writers. This is attended by students of colleges and university, besides general public and reports of such seminars appear in news papers. Marathi Sahitya Sammelan is a big annual event of Marathi literature, attended by 50,000+ people. Once in two or three years, a topic on science is selected and popular science writers participate into it.

Although, a good movement is run by popular science writers and research scientists in Maharashtra on spreading scientific knowledge and science temper, large section of society is still under the influence of superstition, myths, wrong conception and god men.

References – 1) Two articles of Mr. Niranjan Ghate
2) Anthology of science articles in Marathi (1830-1950) by Marathi Vidnyan Parishad & Vigyan Prasar, New Delhi

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SAMANTA CHANDRA SEKHAR: A GREAT ASTRONOMER FROM ODISHA

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1. Introduction:

Today's Odisha formed a part of the ancient Kalinga Empire which once extended from the Ganges to the Godavari. It was historically famous for its remarkable valour, maritime adventures, monumental architecture and wonderful art & culture. And this culture was in continuous tune with the age-old Indian wisdom which is visible throughout the subcontinent. Quest for knowledge and truth, apart from making life beautiful and meaningful, has ever been the Indian seekers' motto. Imprints of such quests are abundantly envisaged in the Vedas, the Upanisads, Puranas and numerous subsequent works encompassing almost all basic branches of knowledge like philosophy, science, mathematics and medicine.



Mahamahopadhyaya Chandra Sekhar Singh
Samant Harichandan Mahapatra
(1835-1904)

India excelled particularly in philosophy, astronomy and mathematics right from the Vedic age. The studies on astronomy were systematized in the 6^{th} century with the advent of Aryabhata. It laid the foundation of the siddhantic age which continued one and half millennium with the bloom of great genius like Varahamihira, Brahmagupta, Bhaskaracharya and Nilakantha Somastva. Samanta Chandra Sekhar, who lived and worked in the 19^{th} century appears to be the last link of such long chain of great Indian astronomers. Aryabhatiya of Aryabhata, Panchasiddhantika of Varahamihira, Brahmasphuta Siddhanta of Brahmagupta, Siddhanta Siromani of Bhaskaracarya and Tantra Samgraha of Nilakantha are the most celebrated works of the respective authors. In that light, Siddhanta Darpana of Samanta Chandra Sekhar is the magnum opus of this astronomer and ranks in equal order as the aforesaid texts. It is a matter of pride and pleasure that Samanta hailed from this land and worked here single handed, against uncouth odds to produce this work which contains a number of original contributions. We present here a short life sketch of this extraordinary luminary along with an out- line of his work and contributions.

2. Short Life Sketch:

Chandra Sekhar \ as born in 1835AD in the royal family of Khandapada, a feudal state annexed to Orissa after independence. Samanta is the royal insignia attached to his name preceded by the family title, Singh resulting in his full name: Chandra Sekhar Singh Samanta. The descendants of his family are now using Singh Samanta as the family title. Of course, he is widely known as Samanta Chandra Sekhar. Legends go on the birth of Chandra Sekhar pointing to the fact that it was divinely ordained and meant for correcting the confusion that crept into Indian almanac making in the 19^{th} century.

The child was nicknamed 'Pathani' by his mother within a few days of his post natal infancy. Later on he became fondly well known as Pathani Samanta throughout the state of

Odisha and its neighbouring regions. Chandra Sekhar had early education by Brahmin Pundits and was introduced to star identification and some preliminary astronomy by his father. He learnt Odia language, literature, arithmetic and Sanskrit language & literature from the Brahmin Gurus. Then he took to teach himself astronomy from the family library, must be of palm leaf manuscripts. By the age of fifteen he was well versed in astronomy classics like Surya Siddhanta, Siddhanta Siromani and other texts. At this age, he started checking his theoretical studies with observation of stars and planets. To his dismay, he noticed large discrepancies between the predictions of siddhantas and his own observations. This led him to continue the observations and after five years, he was convinced that the classics were at fault. He started to record his observations and at the age of twenty three began to compose Siddhanta Darpana. The work was completed at his age of thirty four in 1869AD. Gradually Chandra Sekhar's name and fame kept spreading throughout Odia speaking regions including parts of the then Bengal and Madras presidencies. The authorities at Puri decided to regulate the rituals of Lord Jagannath Temple according to the prescriptions of Siddhanta Darpana in 1876. And as biographers' record goes, the Gajapati King of Odisha conferred upon him the title of Harichandan Mohapatra in same year 1876. Later on, the British Govt conferred the title Mahamahopadhyaya in 1893 in recognition of his achievements in astronomy.

However, Siddhanta Darpana had to wait for long thirty years to be published on paper which materialized in 1899. It would have been just impossible but for the invaluable selfless support of Joges Chandra Ray, the then a professor at Cuttack college (today's Ravenshaw University). The Nature and Knowledge brought out remarkable reviews on Samanta's work in 1899 immediately following its first publication. He breathed his last at Jagannath Puri in 1904.

Siddhanta Darpana is the most outstanding work of Samanta, although he also authored two other short works, 'Darpana Sara' and 'Darsa Dipika'. These two works published only once are now out of print and rare.

3. Siddhanta Darpana

Two Siddhanta Darpanas are up to date known to have been composed in India. The first one was by Nilakantha Somasatva (1444-1545AD) of Kerala and the second one by Samanta Chandra Sekhar (1835-1904AD) from Odisha. These two authors are far separated

in space and time. Chandra Sekhar came some three hundred years after Nilakantha and was probably unaware of his predecessors' work. However, he was thorough in Surya Siddhanta and Siddhanta Siromani which he quotes frequently in his work.

Usually prominent classics define a siddhanta. Of course, the literary meaning of the word is decision or scientific conclusion. But siddhants as astronomical works have broader characteristics. It is clearly defined by Bhaskaracharya and the other authors. Samanta defines a siddhanta as follows:

यत्र त्रुट्यादि काळः प्रळय चरमकः खेचराणां प्रचारः |
प्रश्नाश्चैबोत्तराणि द्विबिध गणित-समुद्भबो भूतराशेः |
स्थानं भूभग्रहादेर्गहण-खगयुति-ज्या-धनुश्कर्मयन्त्र |
क्षेत्राद्यं गद्यते सद्गणकगणबैरेष सिद्धान्त उक्तः ||

-Siddhanta Darpana, Ch-I, Sloka-17.

The work that deals with time beginning with the smallest unit of *truti* (order of 10^{-6} sec) to *pralaya* (order of 10^{14} years), deals with the motion of celestial objects, poses questions and answers, brings out related physical quantities arising out of two mathematical techniques (spherics and algebra), discusses the geo and celestial spheres, planets, eclipses & occultations and describes the necessary trigonometric formulae & instruments, is called a siddhanta. It will not be exaggeration to say that Siddhanta Darpana carries all these characteristics. The treatise is written in Sanskrit verse, carries five sections containing in total 2506 slokas. Of them, 216 are cited from other sources and the rest are Samanta's own compositions. Here is a table showing division of contents of Siddhanta Darpana.

Table-1: Contents of Siddhanta Darpana

Name of section	Chapter number	Chapter content	Number of *slokas* in the chapter
Madhyama-dhikara	1	Description of time	55
	2	Description of *bhagana*, etc.	25
	3	Mean planet position	77
	4	Various corrections	57
	5	True planet positions	211
Sphutadhikara	6	Finer corrections	161
Triprashna-dhikara	7	Gnomons, etc.	95
	8	Lunar eclipse	87
	9	Solar eclipse	78
	10	*Parilekha* description	37
	11	Transit etc. of planets	111
	12	Alignments of planets	93
	13	Rising and setting of planets	85
	14	Phases of the moon	68
	15	Description of *mahapata*	71
Goladhikara	16	A set of questions	80
	17	Description of the earth	160
	18	Description of the	176
	19	earth (contd.)	124
	20	The celestial sphere	112
	21	Description of instruments: Some deeper questions	251
Kaladhikara	22	Description of years etc.	77
	23	Prayer to *Purushottama*	56
	24	Conclusion	159
Total			2506

4. Some Original Contributions:

Siddhanta Darpana conations substantial improvements over the earlier astronomical works in all four aspects of astronomy namely; observation, calculation, instruments and theory.

4.1 Observations

As indicated in the introduction, discrepancies between the predictions of the ancient siddhantas and his own observations prompted Chandra Sekhar to embark upon serious investigation. He has made it clear in the text that nothing has been recorded in the Siddhanta Darpana without verification by observation.

(i) We present in table-2 & 3, Samanta's values of sidereal periods of planets in mean solar days and inclination of planetary orbits as compared to the values given by the other authors and the modern values.

Table-2: Sidereal periods of the planets in mean solar days

Planet	Surya Siddhanta	Siddhanta Siromani	Siddhanta Darpana	European values as in 1899	Modern values
Sun	365.25875	365.25843	365.2587565	365.25637	365.25636
Moon	27.32167	27.32114	27.3216742	27.32166	27.3216615
Mars	686.9975	686.9979	686.9857955	686.9794	686.97982
Mercury	87.9585	87.9699	87.9701577	87.9692	87.969256
Jupiter	4332.3206	4332.2408	4333.7023478	4332.5848	4332.589
Venus	224.6985	224.9679	224.7023478	224.7007	224.70080
Saturn	10765.7730	10765.8152	10759.7741819	10759.2197	10759.23

Table-3: Obliquity of orbits of planets to the ecliptic (in deg. min. sec)

Planet	Surya Siddhanta	Siddhanta Siromani	Siddhanta Darpana	European values as in 1899	Modern values
Moon	4 30 0	4 30 0	5 09 0	5 08 48	5 08 33
Mars	1 30 0	1 50 0	1 51 0	1 51 2	1 50 59
Mercury	5 25 0	6 55 0	7 2 0	7 00 08	7 00 18
Jupiter	1 0 0	1 16 0	1 18 0	1 18 41	1 18 18
Venus	2 46 0	3 6 0	3 23 0	3 53 35	3 23 41
Saturn	2 0 0	2 40 0	2 29 0	2 29 40	2 29 10

ii) In the observation of moon, Samanta Chandra Sekhar noticed three important irregularities. They are: *tungantara* (evection), *pakshika* (variation) and *digamsa* (annual equation).

तुङ्गान्तर पाक्षिक नामधेयं फळं दिगंशाख्य मदस्तुरीयं ।
क्रमेण बक्ष्यामि निरीक्ष्य यत्राचित्रांगतिं रात्रिपतेश्चिराय ।

-Siddhanta Darpana, Ch-VI, Sloka-6.

Of course, evection and variation were known to Munjala (Laghu Manasa) and Bhaskara. But it is definite that Samanta is the only traditional Indian astronomer to have noticed and measured all three. By the by, Tycho Brahe (16[th] century) in Denmark was the first European astronomer to have detected and measured all three. We cite in the following table, the maximum values of these irregularities with J C Ray's reasoning to compare with the modern values.

Table-4: Maximum values of Moon's irregularities in deg. min. sec.

Sl. No.	Irregularity	SD value	Modern value
1	Evection	2 40 0	1 17 0
2	Variation	0 38 12	0 39 31
3	Annual equation	0 12 0	0 11 9

Ray's clarification points to add the greatest equation with evection which results as follows. Modern value: 6°18' + 1°20' = 7°38' and SCS value: 5°!' +2°40' = 7°41'. So Samanta's results are in close agreement with the modern values.

(iii) Samanta's planet placing: It is definite that neither Samanta Chandra Sekhar nor any of the traditional Indian astronomers had the correct estimate of the planetary distances; although the earth-moon distance was almost correctly known as compared with the modern value. But there is an interesting point about the planetary distances; and it is their relative proportion. We cite in the following tables (Table-5,6&7), the circumference of the planetary orbits as in different works and their ratios with respect to that of the sun. Of course, in the modern term, this ratio follows a rule known as Bode's law. It may be noticed that, this principle is inbuilt through Samanta's planet placing.

Table-5: Planetary distances in AU

Planet	Distance according to Bode's law	Actual distance
Mercury	0.4	0.387
Venus	0.7	0.732
Earth	1.0	1.0
Mars	1.6	1.524
Asteroid belt	2.8	2.68
Jupiter	5.2	5.203
Saturn	10.0	9.539
Uranus	19.6	19.19
Neptune	38.8	30.1
Pluto	77.2	39.5

Table-6: Circumference of planetary orbits in *yojanas*

Planet	Aryabhatiya	Surya Siddhanta	Siddhanta Siromani	Siddhanta Darpana
Sun	2887668	4331500	4331497	47800800
Mercury	695472	1043209	1043235	18456420
Venus	1776420	2664637	2664623	34655580
Mars	5431296	8146909	8147108	72303600
Jupiter	34250136	51375784	51376035	245832000
Saturn	85114488	127668255	127671803	441237600

Table-7: Ratio of planetary distances

Planet	Aryabhatiya	Surya Siddhanta	Siddhanta Siromani	Siddhanta Darpana	Period in years
Sun	1.00	1.00	1.00	1.00	1.00
Mercury	0.24	0.24	0.24	0.3861	0.24
Venus	0.615	0.615	0.6143	0.725	0.615
Mars	1.88	1.88	1.88	1.5126	1.880
Jupiter	11.86	11.86	11.86	5.1028	11.862
Saturn	29.47	29.47	29.47	9.230	29.450

(iv) Estimate of sun-earth distance (astronomical unit): One may notice from the data presented in the above tables that Samanta's value of the AU comes to be 6.09×10^7km which is 0.4 of the modern value of 14.96×10^7km. This is of right order of magnitude and is an appreciable improvement compared to the other traditional values. It is striking that Samanta arrived at this result from observation of a pinhole image of the sun through a palm leaf fence in his neighbourhood.

(v) Observation of transit of Venus: Samanta is the only traditional astronomer who records the observation of any specific astronomical event in a siddhanta. A transit of Venus took place in 1874 which the astronomer observed and studied. Following is the description of the author:

दृष्टं सुक्रश्य गाढ़ास्तमयसमयजं मण्डळं चण्डभानौ
कीटांशे पञ्चबिंशे गतबति कळितोऽस्थोऽद्रिगोऽब्ध्यब्द बृन्दे ।
भास्वत् बिष्कम्भदन्तांशमितमित इदं खार्थषट्योजनं स्यात्
इत्यन्यजज्ञेयमस्मात्तनब इनस्तनोस्तारकाः कोर्ग्रहाःस्युः ।

-Siddhanta Darpana, Ch-XI, Sloka-110.

Here Samanta says: In Kali year elapsed 4975, when the sun was in Scorpion at 25°, the transit occurred. The planet during its heliacal setting was seen on the disk of the blazing sun. Its visual diameter was estimated to be 1/32 that of the sun. The true diameter was found to be 650 yojanas.

4.2. Calculation

Observation and calculation go side by side in astronomy. Samanta seems to have verified or rectified thousands of numbers that one confronts in study of an astronomical text. He deals with intricate calculations with big numbers and computation of trigonometric functions and their inverse with utmost accuracy. Thousands of figures given in the data tables (saranis) in appendix are simply an amazing feat.

4.3. Instruments

Samanta Chandra Sekhar was a naked eye astronomer as all other traditional Indian astronomers. He used the scriptural methods for observation and measurements with finer innovation or variation. He devotes the whole 20th chapter of Siddhanta Darpana with about 110 verses to description of nearly 20 types of instruments. His instruments are simple and handy, fabricated out of wood and bamboo chips or such cheaply available materials. Of course, with them he attained fair accuracy in measurement. His constructions were in contrast with the massive masonry works of Jantar Mantar built by Sawai Jai Singh of Rajasthan in the 18th century.

4.4. Theory and model

Samanta Chandrasekhar has, in a number of instances, views drastically different from his predecessors in India. One particular such view is his model of planetary system.

According to him, the Earth is stationary. Sun and moon move around the Earth; but five naked eye planets, i.e., Mercury, Venus, Mars, Jupiter and Saturn go round the sun and with that revolve round the Earth.

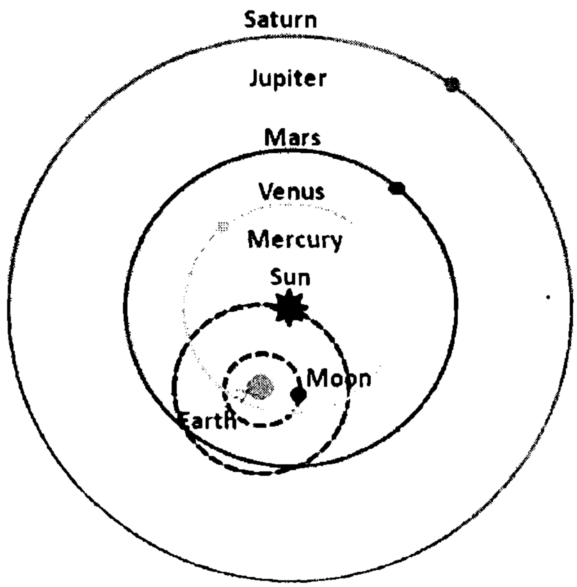


Figure-1: Samanta's model of planetary system

This is a peculiar helio-cum-geo centric model. It is pertinent to point out here that Tycho Brahe in the west and Nilakantha in Kerala in the 16' century also put forth such model.

5 Samanta's place in astronomy

The Nature in 1899 wrote, "Professor Ray compares the author very properly with Tycho. But we should imagine him to be greater". The Knowledge same year opines, "But the work is of importance and interest to us Westerns also. It demonstrates the degree of accuracy which was possible in astronomical observation before the invention of the telescope, and it enables us to watch, as it were, one of the astronomers of Hoary, forgotten antiquity actually at his work before us to-day".

Therefore we would conclude as we did in 1995 (P C Naik & L Satpathy, Current Sc): "It would be probably fair to state that Samanta Chandra Sekhar belongs to the same class of Indian astronomers as Aryabhata, Varahamihira, Brahmagupta and Bhaskaracharya".

6. Samanta's relevance today

It may be argued: What is the need of traditional astronomy and astronomers when we have modern western astronomy founded on solid theory and profuse data stock at our hand? Well, there is need. For, in our Indian society and religious rituals, we follow almanacs which are prepared as per traditional texts. So traditional astronomy cannot all total be discarded.

Besides, as was in Samanta's time, presently the local almanacs do not agree with each others; nor also accurately with observation. So it is time again that Siddhanta Darpana be meticulously studied and utilized to settle such issues. Further, Samanta's life and his dedication to science is an instructive example for our younger generation. They should learn to cultivate the courage and confidence which Samanta boldly demonstrated by declaring,

प्रत्यक्षानुभवं न लुम्पति वचो युक्तिः

Verbal arguments only can never override direct observation.

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Science Journalism

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SCIENCE THROUGH RADIO IN INDIA: A TRADITION IN SEARCH OF CONTINUITY

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National Awardee for Science Communication

The institution of All India Radio started its journey in 1927 from two cities of India namely Calcutta and Bombay. Till the first few years of the 21st century this had been the only broadcaster that aired radio programmes from Indian soil. Historians in India have hardly bothered themselves with preserving the history of broadcasting. They have rarely looked at this phenomenon as an important component of social dynamics. Thus the present generation only has a few memoirs of popular broadcasters and famous administrators from which to guess how broadcasting developed in India. Even these memoirs have very little to offer in terms of science broadcasting. The reason is simple – All India Radio, in its formative years, attached very little importance to discussing science.

Early Days

Prodded by a thoughtful editor of a book, I did a literature survey to find out how much science was there in the first fifty years of broadcasting from All India Radio, Calcutta (now Kolkata). The findings were extremely disappointing to say the least. In order to understand the scenario in its proper perspective a comparison with the American scenario would not be improper. On December 30, 1951 at a symposium organized by the American Association for the Advancement of Science in Philadelphia, Watson Davis, Director, Science Service, Washington reminded the audience of the statement of purposes of Science Service composed way back in 1921. It read, "In a democracy like ours it is particularly important that people as a whole should so far as possible understand the aims and achievements of modern science, not only because of the value of such knowledge to themselves but because research directly or indirectly depends upon popular appreciation of its methods. The specialist is likewise a layman in every science except his own and he, too, needs to have new things explained to him in non-technical language. Scientific progress is so rapid and revolutionary these days that no one can keep up with it without some means of keeping in close contact with its new ideas and discoveries".[1] In the early 1920s, Indians, under the rule of the British, could not even think of getting primary education, leave aside the option of being treated to latest scientific information. India's scientific establishment was microscopic and nothing to boast of. Hence it could have been natural for the Indian Broadcasting Company that started broadcasting in 1927 to ignore science as a part of their content. Tidbits of information on scientific discoveries or the technology of widely used instruments did fill tiny portions of their chunk but that is not worth mentioning. Music, drama and news filled the hours of broadcasting. In fact, once the famous scientist Prafulla Chandra Roy refused to contribute an article to a special issue of Betar Jagat (Trans. Radio World) saying that radio did nothing to educate the masses.[2]

The role of radio changed after India gained independence in 1947. Large chunks of time used to be allotted for agricultural programmes. It was felt that agricultural output could be increased through scientific intervention but the farmers need to be informed about the interventions and radio was the best medium for it. In fact it is now acknowledged throughout the world that India's Green Revolution was largely made possible by the services of All India Radio. Similarly, programmes were mounted to address the health problems of the citizens especially that of women and the newborn babies. But music continued to receive highest priority followed by drama. Science was probably needed only when a producer could not complete his layout of programmes with other subjects. Even world-shaking events in the field of science and technology received feeble attention from the AIR producers. One would be puzzled to find from the programme schedule of the latter half of 1969 that AIR, Calcutta did not consider man's landing on moon too big an event. A talk here and a news item there was all that the station had to broadcast on the subject.[3]

Change in Policy

A change of heart occurred at the Ministry level during mid-seventies. It was decided to set up exclusive science cells in some AIR stations of the country. The seven centers chosen for the purpose were Calcutta, Ahmedabad, Bangalore, Bombay, Delhi, Madras and Trivandrum.[4] The decision must have been taken keeping in view the developed state of scientific establishments in those cities. Regular science broadcasting started from January 1, 1977 in Calcutta. The teething problems were very much visible with very few resource persons available for science broadcasting. There were no dearth of successful scientists in the city but only a

handful of them had the eagerness and the capacity to speak about science in common man's language. It was no easy task for the science producers to fill up more than two hundred minutes of time slot allotted per week. They had to train youngsters for effective science communication. Different formats ranging from talks to features were used for science programmes. Activists of science clubs in West Bengal were involved in the programming process. The staff of science cell even went out to the villages to record queries that could be explained with the help of scientific theories. This led to the birth of several Radio Science Clubs in the state, which conferred among them frequently, and the science cell of AIR Calcutta took keen interest in the process.[5]

Thus a tradition was born, not only in Calcutta but also in all the other cities that had a science section ticking in the premises of All India Radio. Listeners instantly liked the new presentations that were filled with information on the origin of our very own planet, the solar system and the universe. Children, adolescents and elders - all enjoyed the effort at explaining the incidents happening around us with the help of science. The science sections were flooded with fan letters. Listeners were curious to know more. For many of them it was a novel way of knowing science outside the drudgery of classrooms. Radio did not have any competitor on the electronic plane and the science programme producers were not required to bother about commercial rating points. They were at liberty to design programmes on their own. Being the only electronic medium at that time it was not a problem to have talented scientists as talkers, interviewees or science fiction writers. Aged listeners remember even today the euphoria surrounding certain programmes. All the science sections of All India Radio in the country had some programme on astronomy. In Calcutta, the curator of M P Birla Planetarium, Ramatosh Sircar, anchored a programme that was broadcast in the evening. As a veteran astronomer he knew which star would be seen in what direction at what time of the night. Hence he could record the programme beforehand or when situation permitted, broadcast live from inside the studios. He invited the listeners to carry their receiving sets to their rooftops and match their observations of the sky with what he narrated. It was a overwhelmingly popular programme! There were other programmes that aimed at clearing the cloud of superstitions from the mind of the listeners. One such programme from AIR Calcutta had the photograph of a palm being examined by several astrologers and commented upon. The astrologers forecast various courses of life based on the lines of the palm that the photograph contained. Finally it was revealed in the programme that the palm in the photograph was actually of a chimpanzee. Subsequently the illogical nature of astrology was explained to the listeners. In this way the tradition gained momentum.[6]

Lacking Foundation

However, it was a tradition without a proper root or foundation. India has always been a country that has reposed its trust more in religion than in science. The colonial occupation of the country did not allow scientific research to flourish in a natural way for two hundred years. As fallout, the citizenry never looked up to science as a course builder for their life. Therefore, the Indian listeners in general did not have ready ears for science broadcast. They could not be blamed. They had not seen the triumph of technology that changed lives in Europe or America. For them the medicine that saved their lives and the science that they learned from textbooks hardly had any correlation. The present scenario is no better with science reporting occupying less than three percent of space in the Indian media. It is far below the desired level of the 10-15 per cent level.[7] Again out of this the largest contribution has been and remains that of All India Radio.

Another factor that contributed to the tradition not having a strong foundation was the non-existence of a qualified content generating unit. It is true that officers in science section had background in science education and they received strong cooperation from the scientists and science educators of the concerned region. But that was not enough. The official demand on producers for maintaining books and records is so high in the country that they are left with very little time to contemplate a new science production. The science sections would have done well with a supporting body like Vigyan Prasar. In the last few years this autonomous organization under the department of Science and Technology, Government of India has been collaborating with All India Radio in producing remarkable science serials in all the recognized languages of this vast country. But this is a time when sympathy for public broadcasting is waning and science broadcasting faces a more acute crisis than ever. Programme staff strength in All India Radio is dwindling fast and the public broadcaster finds it very difficult to take advantage of the support that Vigyan Prasar is providing. Had this support been there in the late seventies or the eighties, it could have been a different story altogether. Consequently, science sections of All India Radio would have had a stronger presence and could have commanded more resources and staff strength. It might have boasted of a Natural History Unit like that of BBC. In any case it cannot be forgotten that the initial idea of our leaders was to build All India Radio in the design of BBC.

Nationwide Science Programmes

To prove the point mentioned in the earlier section it would be enough to describe the example of the radio science serial on human evolution broadcast in the early

years of the last decade of the past century. This serial was broadcast every week throughout the country every week in various languages.[8] The National Council of Science and Technology Communication (NCSTC) collaborated with All India Radio in this project. It was the first major collaboration since the establishment of NCSTC in 1982.[9] The synopsis and outline of each episode used to be chalked out at New Delhi and distributed throughout the country. Individual stations reoriented it in their own language for broadcast. It was a thumping success for science broadcast in the country. History was written in the period between 1991 and 1994 as a huge network of listeners was built up through registrations and subsequent sending of mails and science kits to them. In a period of little more than three years listeners got used to a unique culture of science. Several off-broadcast activities related to the serial helped in building the mood. But there was no planning in New Delhi to preserve this mood. The next such collaboration came after a huge, unhealthy gap of fourteen years in 2008. By that time listeners had lost the regard for All India Radio as a fountainhead of scientific information. We just frittered away our advantage.

The Format Problem

It is absolutely impossible to delink the format of any radio programme from its content. The format is also chosen keeping in mind the target listeners. The talk, which is a bare format, requires a very skilled communicator. Articles from print medium are a flop when broadcast on radio without any change. Radio has its very own attributes and a scriptwriter has to keep those in mind if he wants his product to be radiogenic. Talks would cater only to the initiated listener. For an uninitiated listener elaborate formats like documentaries and features are required. Health tips for the common folk may be well communicated through musical compositions. The term 'folk media' is often used to refer to compositions that contain very little or no cutting edge science, is designed in the traditional performance styles of jatra, dashkatia etc and aims at conveying simple rules of healthy living or forest preservation. While this folk media is always eulogized beyond limits there is reservation about the same.

Antonio Gramsci pointed out neatly that the system of school education essentially combated the ideas inserted by folklore. He wrote, 'The scientific ideas the children learnt conflicted with the magical conception of the world and nature which they absorbed from an environment steeped in folklore;' Now here we need to identify those 'children' in the modern context where there are bustling cities co-existing with villages. 'Children' spoken of by Gramsci can be found in those villages where folklore has a crucial role to play. The cities have relatively freed themselves from the trappings of folklores. The majority of listeners of All India Radio are those grown up 'children' of the villages. Though their folklore influenced thoughts had suffered a clash in schools or, for some people, in colleges with scientific facts but their essential mental setup remains tied to the messages of folklore and its religious thoughts. The village cultures where even easily accessible video parlours fail to affect their religious moorings are responsible for the same. For example villagers in West Bengal identify themselves with Jatra, Kabi Gaan, Tarjaa, Keertan etc and revel in the action of performers that portray religious figures. They do it throughout their life without feeling tired. They love the unchanged folk formats and wish to enjoy the same all through their lives.[10]

Science, however, represents change. Be it the discoveries of Galileo in Italy or the findings of Susruta in India – scientific facts have always posed an antithesis to the religious beliefs. Therefore, logically, there has been resistance to scientific presentations from within the heart of the villagers.

Utilities and Civics Replacing Science

In almost all seminars concerned with science communication these days the specialists seem to agree on one point – there is more need for conveying the essential formulas of healthy living and sustainable development than to apprise the countrymen about new developments in the field of science and technology. While agreeing with the specialists to a certain extent it has to be strongly stated that any attempt to dilute science communication with heavy dose of utilities and civics will have disastrous consequences. The support in favour of scientific temper will just be gone! We shall be heading back to the dark times.

All India Radio has several programmes that make the listeners aware about hygienic habits and afforestation. But when one finds that this type of items fill up the space for exclusive science broadcast, one feels cheated! A scan of programme schedules of most of the All India Radio stations in the country will prove the argument. While for smaller stations the problem of finding qualified resource persons is certainly a problem this could have been overcome with continuous exchange of programme with larger metro stations. It will be a lie to say that this does not occur but only when energetic programme producers take the initiative. It needs to become a routine for the continuation of a tradition that is becoming weaker by the day.

Way Ahead

It is a fact of life in India that science broadcast becomes a reality only when All India Radio takes the charge. Long

years of experience have seasoned the staff members to catering effective science programmes. We continue to create new dimensions to our tradition. However it has to be appreciated that the current scenario of broadcasting differs in many aspects from the past ones. In the last few decades there has been large expansion of All India Radio network in the country. Since 2003-2004 private FM players have joined the party. But above all television has penetrated the homes and minds of our citizenry in a big way. The mounting popularity of ever increasing television channels poses a real threat to the existence of radio. But it can never be denied that radio enjoys today and will continue to enjoy a niche listenership in the days to come. It still has a huge following in the villages. But instead of remaining complacent we seek to tackle the challenges of the new century through innovative ways.

This author has been presenting live science on FM channel for the past eleven years. It is a unique journey that has seen no break. Science on a popular FM channel was something unthinkable but this programme has drawn into its fold listeners of all ages from the city, suburbs and the villages alike. It hardly needs mention that private FM broadcasters would never give science even a backseat fearing loss of revenue. Again, apart from a handful of exceptions Community Radio Stations in the country are yet to come up to a level where they can sustain themselves. They are, in many cases, neither economically viable nor able to generate the content that can fill up their broadcast time. Thus the science broadcast initiatives of All India Radio needs to be strengthened in the best interests of the country. Hope the law makers and the people in general will take a renewed interest in enriching the tradition of science broadcast the country with the continuity factor.

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SCIENCE JOURNALISM FOR DEVELOPMENT OF RURAL INDIA

Dr. Pramod Kumar Mohapatra
Seniar Jurnalist 'The Samaj'
&
Popular Science Writer.

21st Century is the century of knowledge and knowledge is power. Now science is developing at a great speed and each and every moment the world is changing. It is the first and foremost duty of all science communicators, science journalists and popular science writers to educate our common people, future generation with current growth of science. In my opinion print and electronics media are the best medium through which we can do this work. From the history we see that our literature has been saturated with ancient methodology.

The literature and civilization of our land have been profoundly influenced by our scriptures and mythologies; and thus evolved. Our rich civilization would not have been possible without that scriptures in our literature. The Mahabharata reflects Indian Life, through and character in their totality. What is Mahabharata? It is the narrative literature or picture of the events of that period. It carries the information of past civilization and way of living of our predecessors. If the news of that time is eventually recorded in a daily basis it would have called a news paper. The Mahabharata is collection of both humanatory as well spiritual actions, events and thoughts of people of that time, gathers and collected together and got transformed into Thesis. The Mahabharat is virtually a collection of events narrated by Sanjay to Dhritarastra. Sanjay acted as a reporter or correspondent as we see in todays modern news cahnnels. In the same way Vyasa did the editing of this noble Mahabharata. Therefore, it would not be an exaggeration to call the Mahabharat a great mass of Journalistic literature. Similarly, the Ramayana is an indispensable chronicle of the growth of civilization, culture and literature of our land. The Ramayana can also be called a collection of timely gathered news from news papers of those times.

This proves that even in the past we had efficient news reporters and editors who have left us a rich legacy of Journalistic Literature in the form of epics.

History of Science Journalism: In ancient time our society was small in size. There was no occurrence of evolutionary events. Ancient people used to lead their life in a esoteric art form. But as the time passes on the human society get bigger and bigger and gradually the need for different things increased day by day. This leads to the evolution of scientific research and developments. Art is mostly guide by intuition. For example let us consider the evolution of iron making technology. In ancient times, very few people knew about iron making. Those who knew about it, kept it a closely secret. This esoteric knowledge used to get transformed from generation to generation. But now the scinario is changed. Now knowledge is being shared by people and knowledge pool continues to grow rapidly and incorporation of scientific basis, modern steel making technology has evolved.

Modern science has a history of about 450 years. It has a important role in developing the knowledge of people in physical and biological world. The impact of new research and developments make our life style change in a more smoother manner. This tremendous growth of scientiiics research were stated from all over the world. The countries like Greece, India, China, Western rope. United State of America, Japan have contributed in a great way to the development of science. During last 150 years science has touched the civilization of all most all countries through out the world. Science is a human venture. The scientific community is an international community, which is beyond cast, sex, class, religion and nationality.

It is the matter of satisfaction that now almost all the newspapers published from India are giving, equal importance to the news related to scientific research and developments. Weekly-pages on science, health, agriculture and environment leads to increase and globalise the knowledge among people. To be a good science writer it is required to have good knowledge of the basics of science. Hunger to get updated about new technologies, adoption of latest information, good communication and writing skills are some of the essential parameters that are required for a science writer. Science writers, journalists like must have an insatiable appetite for reading and the best are endowed with a memory like a tiling cabinet.

Our country is an unique place in the world where people use 1652 language for communication and 70% of the total population are living in village. In Orissa this rate is nearly 80%. Even at this generation blind belief and superstation is a general thing not only in tribal areas but in rural areas. If a cat crossed the road, it is still a belief that one

should take a few steps backward. The number of so called Baba's. Tantrika's, god men are increasing day by day. Human sacrifise for more production, sacritise of goat, buffalos. Birds are a common sceen during puja occasion. People also ignore going to hospital in case of heath hazards and prefer to get treatments from Babas and Tantriks who certainly do not have any knowledge about Medical Science. Till now they do not prefer toilet rather use open field as their toilet. In some tribal area childrens are giving hotrod treatment in their abdomen to escape from the eyes of ghost. Till now different kind and size of ghosts are staying in Baneyan tree, Palm trees of rural areas. Light producing female ghost appeared every mid night in some specific areas. People still now love tanlius for their treatment of diseases.

Now the question is who will educate these people with scientific knowledge. Who will tell them that take a water bath to get relief from high fever instead of covering the body with thick blankets. The science writers, journalists must do this service for the benefit of people belonging to undeveloped areas. For this all the science writers must adopt scientific methodology. They must do some research on the topic first, then understand the topic and finally write in simple language so that it is well understood by all.

We all know that Journalism can include topics like History, Economics, Science, Sociology, Literature, Art and many more. But the key idea of Journalism is to spread the knowledge among people in a effective manner. So that human knowledge pool get increase day by day. A school teacher teaches a class of thirty-five to fifty students but a news man educates thousands and thousands of people through Newspaper. A journalist's role is the role of a teacher, a preacher, a philosopher, a chronologists a phycologist, a sociologist, an economist and above all an all round artist.

This is the time when the science journalists should educate rural people with up to data of scientific development. A journalist particularly science journalists must aware our people about the achievements of our country in the field of agriculture research, space programme, medical research, education, information technology, satellite programme, nuclear benefits and so on. Aware to people on scientific achievement:; is a challenge which they should complete in a effective and efficient manner.

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SCIENCE VERSUS SCIENCE JOURNALISM

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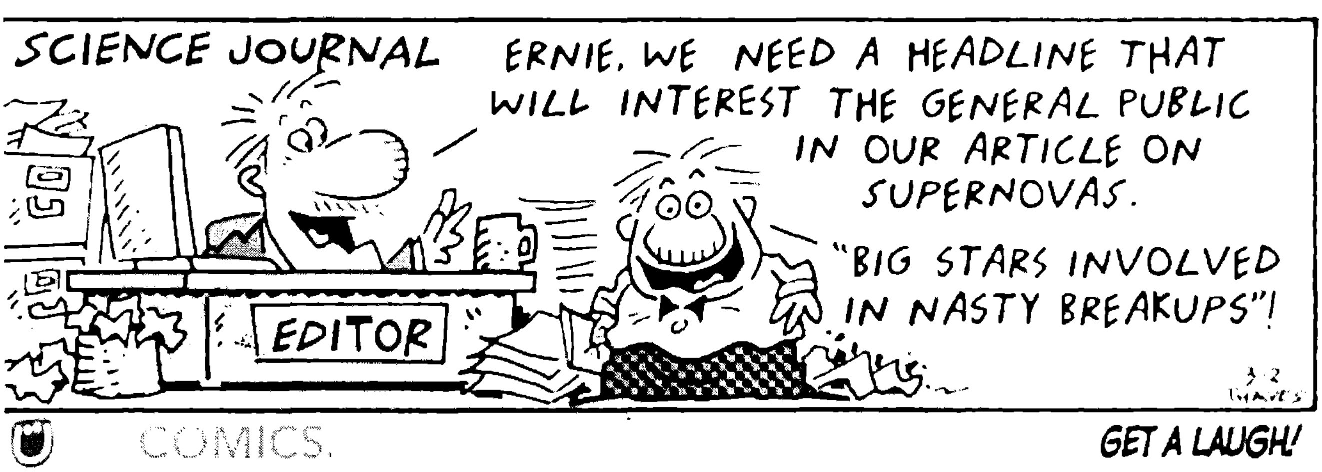
Introduction

In recent years, the amount of scientific news that fills the headlines of print and audiovisual media has increased dramatically. This establishes a clear evidence that science plays an increasingly visible role in the society. News is the building block that helps us construct an understanding of the world we live in. Moreover scientific news is the product of the society, which is prepared by the professionals, often called reporters. A reporter is the professional who presents the scientific news either by translating the exact facts described by the scientists and scientific world or by simplifying these facts into more convincing form. Usually a reporter converts information from a specialized source into something that can be understood by a more general audience who have no previous knowledge of this information. By converting science into science news very often the real scientific knowledge is omitted. Most reporters do not understand the subject; instead they merely reproduce the contents of the press release or briefings. In this process the linear relationship between science and science journalism is lost. In an endeavor to popularize science sometimes media take science as a topic of entertainment and excitement. The popular media usually prefer those topics that are more sensational and more entertaining. In this process media forget the real objectives of popularization of science.

Reality And Probability

Science and science journalism are two distinct pillars of modern society. The relationship between these two disciplines is not as simple as it looks. Science is not a linear process of steps and breakthroughs. It is important to realize that scientific truth and the truth in the news media are not equivalent[1]. The reality behind each discovery and breakthrough is constantly subject to review and revision. The uncertainties associated with every scientific program are accepted as working theories. Sometimes failure in any scientific research can be used as stepping stone to a better level of understanding

Scientific knowledge is not like an absolute constant. The scientific information that we have today may change tomorrow with some new discoveries. But science journalism usually gives no account of the trials and errors that actually occur along the way of discoveries. We should not forget that what appears as a technological achievement today has roots in some scientific discovery in the past. However in science journalism very often the actual scientific discovery is ignored, while the technology is highlighted[5]. During 2009 when nobel prize was awarded to Kao, Boyle and Smith for their research on optical communication, the media highlighted only the technological applications of fiber optics but hardly it emphasized the basic principles of transmission of light through fiber optics.



With technological advancement in every field there are disasters also. Just recall the recent nuclear meltdown of Fukushima Daichi in Japan during its tsunami in march 2011. Soon after that media spread the news that nuclear energy is not at all safe and such nuclear programme should be abandoned. No doubt making aware of such disasters is a duty of science journalism. But suspending developmental programme by anticipating natural disasters like earthquake, tsunami, cyclone etc is not at all wise. Even in country like USA fifty percent of its population is not in favor of nuclear reactors. Whenever any disaster or failure in scientific programme such as missile test, SLV lunch etc happens here is a popular reaction against science. "Chandrayan " mission of India has also faced lots of criticism from science journalism.



The reliability of source is also an important issue that cannot be overlooked in an analysis of the production of scientific news[1]. Statements and press release by some important persons, institutions, organizations are widely accepted even without validation. Such unquestionable authority that exists with some sources can lead to some serious problem of misinformation. Moreover, sometimes a large quantity of misinformation that is delivered to the public is never corrected. If at all, it is corrected after a long time the general public usually remembers the earlier uncorrected version of the fact. An example of such news is: that NASA has found the first signs of extra terrestrial life in a meteorite in Antarctica(August 16,1996 issue of Science)[1].

Present Status And Perspective

One of the reason for science journalism to have remained underdeveloped in our country and abroad may be due to unattractive mode of science reporting employed. May be this is why common people are still away from science and technology. Even in western countries science journalism has been facing trouble in recent years because of economic crisis Twenty years ago nearly 150[1] American news papers had a science section . but now it has reduced to 20 only of the 1750 daily papers published in USA only 50 newspaper employ full time science reporters

If science were presented in the form of stories , poems etc. common man not only would read those but also would appreciate science. Poetry is also a very powerful medium for communication which could be used specially for children , neo- literates and rural people. Science popularization through postal stamps, postcards, greetings cards, calendar, diary etc. are very potential media which has not yet been utilized . It can be appreciated here that a small country " Nicaragua" of Central America has been popularizing science since 1970s through a series of postal stamps named **" The Ten Mathematical Formulae that changed the face of the world".**

In India postal stamps have been released on scientists and scientific institutions etc. but no one has ever studied its impact on people and society. Therefore science journalism first of all requires a research base for its development. In a multilingual and multi cultural country like India science journalism should adopt appropriate strategies for science popularization. In western countries films, theaters, operas etc. utilize science for entertainments. But in India rarely we come across science drama, science skit, science based films and operas.

As an average , the science coverage in India is only around 3%. Since scientific information is generally available in English, translation to other languages is a greater challenge. Misleading scientific information, distortion in translation, dilution of facts, exaggeration of events, inconsistency in information are serious drawbacks in science journalism in India. Moreover conflicts between scientists and science journalists are also a serious impediment towards science journalism in India.

Wolfgang Goede[2], editor of the successful German popular science magazine and co- founder of the World Federation of Science Journalists, says journalists don't report on the process of science because "very few of us have been trained and, more importantly, encouraged to look at science as if it were apolitical party or a public enterprise- those things we have been brought up to criticize". The statement is a clear evidence that not only in India but also in western countries the science journalists are not well trained. However the present scientific world needs perfect professionals for science reporting. Moreover , the investigative journalism is the much desirable aspects of science journalism which demands much more professionalism. A large number of our science writers and scientific journals of India are from public sector[4]. We don't expect general journalists to be so analytical and self- critical on scientific issues. Most of our research and developments are carried out in universities or government organizations ,institutions and laboratories. Hence common people don't get a chance to know what exactly the scientists are doing. To bring the knowledge gained by research to the use of common man there is a need for investigative journalism. So it is very true that only specially trained science journalists can effectively carry out proper investigative science journalism. Now time has come when science journalism should develop as a separate branch of journalism to do justice to science communication.

Of course it is important how much average science coverage appears in a country . but it is also imperative to study its consequences, its effect on society. In a country like India when a big fraction of its population depends on print media turning most of its popular magazine to online magazine not that wise. Translation of scientific information to regional and local languages should be taken seriously. Glossary of technical words should be developed keeping in view the popular words of that language and region. In India since 1982 National Council for Science and Technology Communication(NCSTC)has been established as an apex body to take care of science communication and science popularization in the country. However along with various government and non – government organizations scientists, science teachers, science writers should come forward in a big way to popularize science.

Conclusion

The scientist have a great role in science journalism. They should be accountable to the common mass to inform them about the work they are doing[5]. Moreover, scientists should interact with journalists on regular basis to defuse their research findings to the society. Of course it is true that values of scientific community is very similar to the values of democratic society. The growth of science journalism requires certain supportive values particularly liberty. According to Markandeya Katju[6], " Liberty cannot be equated with license to spread superstitions , to promote irrational beliefs or social strife". Hence, science journalism is the watch dog of social evils. It should realize its importance in spreading scientific ideas amongst the vast mass of India, raising their cultural levels and involving them actively in the task of nation building.

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POPULARISATION OF SCIENCE THROUGH MASS MOVEMENT

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"Popularisation acquaints the public at large with the power and efficiency of creative science".
Jean Rostand, 1960 Kalinga Prize Awardee for Science Popularization

Introduction:

Science is playing an influential role in our lives. A rapid change in Science and Technology has significantly changed our lives. His Excellency, the President of India Dr. A.P.J. Abdul Kalam, addressing citizens on National Science Day said:

" Today Science has touched every person in all walks of life be it rural or urban.... be it faith in a cure for every illness, increased productivity in agriculture, pre-emptive action in disaster, communication in cell, STD or VOIP, enjoying television shows at home and realisation of the world as a global village ... everywhere we see science in action."

Public Communication of Science & technology is important for the economic and social well being of society and for exercise of participatory democracy. Realising the importance, our leaders had incorporated this in the S&T Policy 2003, some of the excerpts of which are quoted below:

- To ensure that the message of science reaches every citizen of India , man and woman young and old ....and make it possible for all our people to participate fully in the development of Science and Technology and its application for human welfare.
- ...People must be able to consider the implications of emerging science & technology options in areas which impinge directly upon their lives, including ethical and moral, social and economic aspects.

The basic objective of communicating science to the common man is to inculcate in them scientific temper. Realising its importance, way back in 1976.

The 42nd Amendment Part IV-A Article 51- A on Fundamental Duties got added to our Constitution. The article 51-A (h) reads:

"(It shall be the duty of every citizen of India) to develop scientific temper, humanism and the spirit of enquiry and reform."

Action taken so far:

A large no. of steps are being taken by Govt. and Non-govt organisations. Pamphlets, Leaflets, Articles in Print Media; Books, Posters Magazines, Radio, Television, Talks, Debates, Jathas, Slogans, Morchas, Flagmarch with placards, Exhibitions, Museums, Quiz Competitions, Science based Cultural programs and Folk art etc; are only indicative and not exhaustive. Prizes are also awarded as incentives for all these.

A glimpse at the steps taken in the past would indicate that, perhaps no stone has been unturned in this regard. Some are useful, some very useful and some are excellent. Yet, it appears, there is much more that can be done.

Can this be converted to a mass movement - a movement to which people from all walks of life can be roped in? Can they be made to be actually involved and contribute significantly in their own way? Yes, this can be done.

Approach:

India is a vast country with a wide diversity of language, tradition and culture. Further, people belong to different age groups, levels of education, their pursuits of daily life, vocation, profession etc. For example, we have students, teachers, doctors, politicians, peoples' representatives, administrators, assistants, scientists, business people, corporate houses, social workers/self help groups, women groups, tribal groups, industrialists, labourers in organised and unorganised sectors; armed forces of all wings and paramilitary forces etc.

These various groups have different levels of education, understanding, exposure and interest.

Hence, while taking science to them, we can have a multipronged approach. We have to identify the groups, create awareness among their leaders/heads and train them first. We have to adopt different approaches, strategies, methodology, techniques and mediums both at micro and macro levels.

One can design and distribute leaflets, booklets, documents for different groups, organise meetings, training programs, workshops and interactive sessions. The duration of the programmes can be varied, from a few hours to a few days and organise in different locations. For top echelons, we may choose Secretariat Conference Room, Administrative Academies; for MLA's, Assembly or suitable Halls; for MPs, Conference Halls; for Collectors/Block Level Officers, collectorate conference halls and so on. For the grass root level, there are respective Panchayati Raj office premises. These meetings or workshops can be replicated for similar groups at other locations.

The leaders in turn can take suitable steps for bringing science to the groups they head, formulate programs within their scope for inculcating scientific temper, removal of superstition and blind beliefs as well as appreciation of scientific activities & achievements at different levels.

Experience:

The approach indicated above is based on some experience we had in Odisha way back almost three decades hence, in the Deptt. Sc. Tech. & Env. when a massive program was launched for creating awareness on Environment - various issues involved, steps to be taken at different levels, the roles to be played by the various groups and individuals, policies to be advocated for adoption by Govt. etc. A number of incentives and awards were instituted. These have since become a part of the system and have done yeoman service for creating an impact on protection of the Environment in the State.

We can now focus on a few specific groups.

People's Representatives:

India is a democratic country. Policies are made by People's Representatives. Government Machinery is run by a vast network of committed Bureaucracy, overviewed by People's Representatives. They are the persons who interact with people whom they represent. Hence Science should reach them first so that they can appreciate the programmes and in turn take them to the people. They should be briefed about the issues involved and progress in S&T made and achieved. That is the way their outlook will change, at least to a limited extent, help overcome superstition and blind belief, as well as create awareness of Health, Hygiene and Sanitation and protection of the environment.

At National Level: Members of Parliament; Members of Rajya Sabha
At State Level: Members of Legislative Assembly/Council
At Municipality/Corporation/NAC Level: Councillors, Mayors, Chairpersons
At Panchayat Level: Panchayats/Sarpanch

The approach would be to start with local problems/ issues like agricultural production, drinking water, sanitation etc. offering solutions with S&T inputs.

Ex: When seeds and kernel from 5 ripe drumstick are powdered and added to 10 litres of turbid and polluted water, the water will become clean and pure - 99.9% of all indicator bacteria will be free. Such proven technologies can be taken to tribal people for whom it is culturally acceptable, inexpensive and ingredients locally available. This is an extract from a book with more than 500 natural coagulants which has been published.

This approach can be followed at Village and Panchayat levels.

Corporate Bodies:

In addition to the above, there is another group/section that may also be roped in. They are the officers of Major Corporations who contribute to programme of Social Relevance. In fact the Social Corporate Responsibility is now a programme built into the system/organisation. They are already doing yeoman service for the welfare of the society where they are active. All that one has to do is to groom them to bring in S&T inputs into their programs and activities.

Strategy:

The strategy shall be to approach different groups suitably, keeping in mind all aspects described earlier. For example, the people's representatives at National level may be groomed about Science & Technology in broader perspective so that, not only can they appreciate the S&T policies at the highest level, but they may also contribute inputs, keeping their areas in view. In turn it would help them in monitoring the efficacy of the system. This would be similar, if not identical, at the State level.

In case of R&D Institutions & Scientists, it would be exposing them to fields of Science not dealt by them, and groom them to effectively take their contributions to the common man. They may also get feedback from the people about problems and issues faced by them and find S&T intervention for solving them.

Taking another group, Doctors & Health Workers, they need not be retrained in their own profession but can be exposed to basic technologies involved in the latest equipments and methods of treatment including latest diagnostic techniques and therapy, application of Nano-technology, Nano-bio-technology, precision medicine, tele-medicine, Robotic Surgery etc. They may also be encouraged to study the unexplored areas and traditional systems etc.

Man Power Required:

A question may arise whether recruitment and training Role Models is implied in the approach. In a sense it is. Just as NCSTC supports Workshops for "Science Writers", "Folk media", to communicate Science through their arts like PALA, DASKATHIA, PUPPETRY etc. , people entrusted with/interested in popularisation of Science can meet, discuss and develop modules for different targeted groups and propagate S&T. The Communication Institutes under NCSTC/DST can take the lead. Considering the wide range of groups and population involved, and the benefits that is likely to accrue over long periods, the money, manpower and efforts necessary under this strategy is well worth it.

For effective communication of Science and Technology to the public, there should be a mass movement and a Multipronged Approach is strongly recommended.

Students:

Students constitute a major part of the society. As the future generation of the country, this group deserves maximum attention. Rightly so, a large number of programmes are being implemented, besides Science as part of the curriculum.

Under the NCSTC banner a large number of activities are undertaken throughout the year in different parts of India to popularize science. Besides, there are various organizations, institutions, individuals and groups who have their own programs to take science to the common man. Particularly, schools and colleges organize various activities, including popularization of science on occasions like Annual Day, Foundation Day, Cultural Week, National Science Day, Technology Day, World Environment Day etc.

At the National level, we have National Children Science Congress, Indian Science Congress – a large part of which is aimed at and relevant to the common man. Mention may be made about the programmes of Science Centres under the National Council of Science Museums. Similarly the RVPSP under DST organizes the Science Express in collaboration with Foreign Societies. There are also major events like successful launching of Chandrayan-1; it's continuing sojourn and landing on Moon, future program of experiments to be conducted; participation of team of Indian Scientists in the experiment on Large Hadron Collider, by far the greatest scientific experiment ever conducted in the world.

Whereas in the former events the activities are confined to visitors and participants, only a few columns are covered in print media and a few minutes of TV coverage reaches the other areas and common public. The latter events are mostly covered in the print and electronic media only as NEWS ITEMS.

Very often the curiosity of the children and public is not satisfied in this process. It is true that some interesting events are brought out as articles in some magazines – more often devoted for other purposes. Some are available on internet to which only a lucky and privileged section have access.

Important Tools for implementing this program:

One of the most important tools necessary for the success of communicating Science is a National Channel devoted for Science Communication. Honourable A.P.J Abdul kalam , former President of India ,recommended among other things to establish A Science Channel.



A National Channel of Door Darshan devoted for programmes on Science & Technology appear to be a pragmatic solution for taking Science and Technology to everyone.

Further Justification:

For a moment let us consider some channels presently operating in other countries. NASA channel continuously beams programmes related to Space activities, both current launches and past programmes, trainings, seminars, talks, interviews and so on. Similarly National Geographic, Discovery channels have a lot of science components. These are costly and production of programmes of such quality and depth may be out of reach for us at present.

We should do justice by adding that some of the programmes of the foreign channels like 'Discovery'& 'Animal Planet' etc are now available in Hindi. I would still consider them as supplementary provision.

Considering activities related to SCIENCE COMMUNICATION, currently going on in different parts of our country, these can certainly be beamed in a channel devoted for this purpose. All that one has to do is to co-ordinate and pool them – if not make it mandatory to convey the recordings in e-media - to a central point, edit them by an expert group and beam them in the channel.

In our country we have enough talents to communicate Science in a number of INNOVATIVE WAYS which does not reach many corners of our vast country and its heterogeneous public.

Thanks to NCSTC, already the methods of communication have been standardized and are popular. Similarly, technologies are available for rendering texts in one language to any other Indian language.

Crores of rupees are spent, in our effort to communicate science, for production of software which remains confined to limited regions and becomes only a ritual. On the other hand if the details are beamed in a National Channel more people will be benefited.

Let us take the case of National Children Science Congress. It has become almost a mass movement (students). But think of the larger mass of students in remote corners, who have neither been able to participate nor have an exposure of the apex level. Think of what would be their joy and benefit if they are shown a glimpse or more of the programme, exhibits, presentations etc.

Take another case of Science Express. It is an innovative Science Exhibition mounted on specially designed train. This state of the art exhibition covers nearly 20,000 kms over six months and halts at more than50 Railway Stations. The major objective of this unique venture is to nurture curiosity amongst our youth and rekindle their interest in science.

This programme is being repeated very often, almost every year, in collaboration with foreign institutions. The contents are simply superb, stupendous, awe inspiring, highly educative and valuable. One laments to think of the large of student population and public who are deprived of a closure look, if not physically, at least by other audio–visual media. In fact, one would go further and say that a mass briefing before the express reaches the station would be highly beneficial to the visitor for understanding and appreciating better. A TV channel proscribed for Communicating S&T, I hope will serve the best interest.

Felt Need of a dedicated TV Channel:

For communicating Sc & Tech the acute need of a TV channel has always been felt .In the words of Mr. Subir K.Sen, Science shows & documentaries are another very important communication mode for science. Unfortunately we do not have any TV channels or slots in any channel for transmission of indigenous Science Technology & Industries (STI) matters. Elite people, Scientists and Technologists, over the years, have always expressed the need of a TV channel of Science, devoted for Science and Science alone.

The advantages of Television are many. It is audio – visual and can reach more people simultaneously' It is flexitime. Further,

i. Programs can be available and expected in one particular channel.
ii. NCSC can be an alternative to channels meant for "Entertainment" and 'News' about which much can be said.
iii. Production cost would be minimal as many of the programs to be beamed are / would be available in e-form having been prepared at various locations.

The role of Print Media, Radio or other e-media cannot be underestimated. However the advantages of Television appear to be enormous, considering the mobility and other modern technologies by which the communication can reach every individual.

In India's perspective, considering its diversity of population, locations, languages, cultural backgrounds, on one hand and technologies available, money being spent for current programmes and economic viability on the other hand, the national channel has immense potential.

Recommendation / Conclusion:

Hence we should recommend for setting up A NATIONAL CHANNEL FOR SCIENCE COMMUNICATION (NCSC) under the aegis of Door Darshan. It would be relevant to mention that Door Darshan is not a paid channel. Hence NCSC can be made to be freely available through all cable operators. With the help of this tool and Multipronged Approach, we can achieve mass movement for popularisation of Science.

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"The whole of science is nothing more than refinement of everyday thinking"
-- Einstein

COMMUNICATING SCIENCE THROUGH RADICAL MEDIUM: RADIO

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Science is the study of the way nature works. The study is conducted by observing nature, propounding hypothesis on the way it works and finally checking on them by conducting experiments. Any observation or theory which cannot be proved or disproved by an experiment doesn't come under science. Science communication can be defined as interactive transmission of scientific message, information, knowledge, feelings through meaningful signals or symbols from science communicator to another individual or individuals or community. It can also be defined as the sum of all things or one person does when he wants to create understanding in another person or community. Mass media includes Television, Radio, Newspapers, Internet, Booklets, Leaflets, and Magazines etc. More than 72% of people reside in rural areas in India, whereas there is only 3% coverage of Science & Technology through different media, including radical medium radio. A nation is great not because a few people are great, but because everyone in the nation is great.

India has a rich heritage and talented work force and is emerging as a knowledge society. Yet, over 26% of the population is below the poverty line; illiteracy and large scale unemployment persist.

The common rural & urban mass is first of all to be well aware & educated in different aspects like health, education, sanitation, use of mobile communication, food production, information, deforestation, draught, disaster management, new drugs for newly created diseases like swine flu, malaria, Dengue, Television direct to home (DTH), Science in daily life etc.

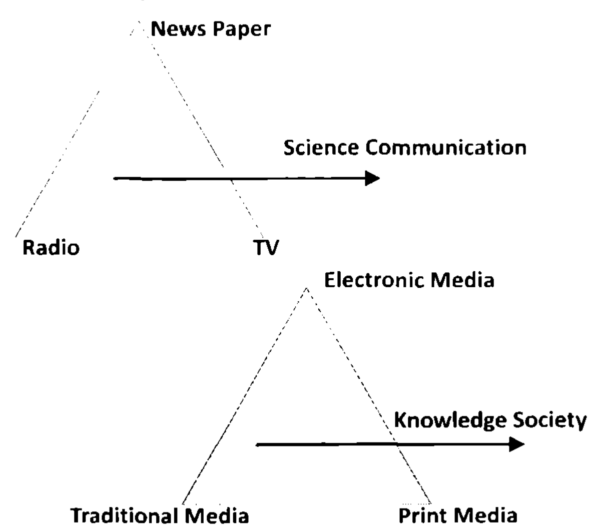
There is profound role of science in everyday life of the individuals. Different subjects should be well communicated to public through cheapest medium "Radio" which is easy to reach in every nook corner of country. That too, science should be communicated through regional languages and local dialects for better understanding.

Different Radio science serials like Human Evolution (Manav Ka Kram Vikash), Drug and Tobacco Education (DATE), Nisarga Sampad, Bigyan Dhara / Bidhi, Prithvi Ama Prithvi, first week of September 2010, in 19 Indian languages and from 117 Radio Stations. Other science programmes which are aired through Radio is Gyan Vigyan, Bigyanika, Bigyan Patrika (fortnightly & monthly) Phula Changudi, Tiki Raija, Sishu Sansar, Krushi Sansar, Nari Mahal, Yuva Van! etc.

For Example science in agricultural programme can be well understood by common mass, like SRI Method or System of Rice Intensification yields more than traditional method of farming,

How to take care of the cattle, hens, and fishes is another important segment in agriculture though different Radio Talks, Panel discussion & phone in programmes.

Sometimes science drama plays an important role in communicating science among common mass. Science episodes, talks, talklets; chunks, commercial breaks, musical hints, common etc. create a greater appeal among common masses. Science communication through Radio is well appreciated by common masses in tribal region like KBK region of Orissa.



While cultivating the land & doing all sorts of manual work in the agricultural field the people never forget to take radio with them to tune to AIR Programmes either in MW or SW Band.

Science Popularization: Way Forward

Orissa University of Agriculture and Technology
Bhubaneswar

The Orissa University of Agriculture & Technology was established as the second Agricultural University of the country on 24th August, 1962 and is undertaking triple functions of teaching, research and extension in an integrated manner. The University has 10 constituent colleges and a Centre for Post Graduate studies. The University imparts technical education in the field of Agriculture, Veterinary Science & Animal Husbandry, Agriculture Engineering, Forestry, Fishery, Home Science and Basic Sciences through 54 UG, 51 PG and 31 Ph.D. programmes with annual student intake capacity of 1782. Now the total student strength is 3944 of which 46.22% are girls. The University has a Central Library with internet, e-library, inter-library loan, CDROM database, online access facilities and a book bank and 1 Gbps (leased line connectivity).

The University has a research network with 8 Regional Research and Technology Transfer Stations, 4 Regional Research and Technology Transfer Sub-stations, 7 Commodity Research Stations, 13 Adaptive Research Stations and 10 Agro Advisory field units spread over all the 10 agro-climatic zones to cater to the needs of farming community of the state. There are 51 All India Coordinated Research Projects, 27 ad-hoc projects and 17 RKVY projects operating in the University. The University has so far developed 128 promising high yielding varieties of different crops, many of which are acclaimed at national and international levels. OUAT is the 1st in the country to launch Agro-met website since 2001 with regular updating of both weather and advisory service in English and Oriya languages. India Meteorology Department (IMD) has accepted the model of OUAT for the entire country. The multi-coloured poultry bird developed by OUAT has good acceptability by farmers and consumers. The University has also fabricated user friendly, drudgery reducing, cost and time saving low cost farm implements for the benefit of farming community. The University has developed also a number of value added products for the benefit of post harvest industry. Till date, the University has registered 13 rice varieties viz., Pratikshya, Jogesh, Mahanadi, Indrabati, Prachi, Ramachandi, Jagabandhu, Kharavela, Sidhanta, Lalitagiri, Udayagiri, Gajapati & Uphar and 2 black gram varieties viz., Ujala & Prasad with the Protection of Plant Varieties and Farmers' Right Authority, Govt. of India. The University produces quality seeds and planting materials of different field crops & vegetables, fish spawn & fry, tissue culture plantlets of banana, sugarcane and gerbera, bio-agents and mushroom spawn which are distributed to the government organisations, NGOs and interested farmers of the state as well as neighbouring states. The University successfully undertakes technology transfer programmes through 28 Krishi Vigyan Kendras (KVKs) established in 28 districts, University Extension Block Programme, publication of extension literature, Distance Education, Video Programmes, Agriculture Technology Information Centre, On Farm Testing, Field Level Demonstration, Farmers Fair, V-SAT Programmes, Farmers-Scientists Interaction and Orissa Gender Resource Centre.

PASSAGE OF PHYSICS :FROM RIGID UNHURRIED TO VIRTUAL HURRIED WORLD

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Quest of Science for Truth & Beauty:

All of us are sensitive to Nature's beauty. It is not unreasonable that some aspects of this beauty are shared by the natural sciences. But one may ask the question as to the extent to which the quest for beauty is an aim in the pursuit of science. On this question French theoretical physicist Poincare is unequivocal when he writes, "The scientist does not study nature because it is useful to do so. He studies it because he takes pleasure in it; and he takes pleasure in it because it is beautiful. If nature were not beautiful, it would not be worth knowing and life would not be worth living". With frightening simplicity and wholeness of relationship nature spreads out before us her beauty perceives as beautiful finds its realization in external nature. What is intelligible is also beautiful and for which none of us is least prepared. What the imagination seizes as beauty must be truth—whether it existed before or not. It is , indeed, an incredible fact that what the human at its deepest and profound,

There is also a difference between the two patterns of creativity in the arts and in the sciences. In assessing an artist, one often distinguishes an early, a middle and a late period ; and the distinction is generally one of growing maturity and depth. But this is not the way a scientist is assessed: he is assessed by the significance of one or more of the discoveries that he may have made in the realm of ideas or in the realm of facts. Most often the important discovery of a scientist is his first. In contrast, the deepest creation of an artist is equally often his last. Interestingly Wissenschaft is a German word for science , which stands for not only natural science but also includes humanities.

The pursuit of science is often been compared to the scaling of mountains, high and not so high. But who amongst us can hope, even in imagination, to scale the Everest and reach its summit when the sky is blue and the air is still, and in the stillness of the air survey the entire Himalayan range and the dazzling white of the snow stretching to infinity? None of us can hope for a comparable vision of nature and of the universe around us. But there is nothing mean or lowly in standing in the valley below and awaiting the sun to rise over Kanchenjunga.

Against the backdrop of the hopelessness of the fear of death, whether it is the prediction of the end of the world or the nuclear leakage or for that matter chaos of facts and opinions , there is always a silver lining, a trail blazer which gives us new, simple and important facts gearing up our life and way of living. Human being silently shares the delight of the revelation of a discovery or an invention; it is no different from the manifestation of perfect beauty, which is rare and unique.

The path to truth is filled with snares and strewn with errors; and failures are more frequent than successes. These failures, moreover, are sometimes just as revealing and instructive as the successes: it is through errors that the mind progresses towards truth. The path towards the goal of truth is not a straight path. It twists and turns, occasionally blocked, sometimes turns back upon itself. It is not even one path but many.

Joys of creativity are not restricted to a fortunate few. They are , indeed accessible to each one of us provided we are attuned to the perception of strangeness in the proportion and conformity of the parts to one another and to the whole. And there is satisfaction also to be gained from harmoniously organizing a domain of science with order, pattern and coherence. The translucence of the eternal splendor through material phenomenon are made iridescent reflected in creative works of science and art.

Stretching boundaries between East & West :

Concept of atom (kana) appeared in India by Kanaada(7th century BC). He founded a school of thought centered on the notion of atom. According to him knowledge is obtained through the agency of six positive categories: substance, quality, action, universality, particularity and inference. Substance in turn , comes in nine kinds: five of them material(earth, water, air, fire and ether) and four non-material(time, space, self, mind).The five material kinds of substance are made up of atoms. The tiniest particle available in nature is a speck in a solar beam consists of six atoms, connected pair-wise by either will of God or otherwise. Kanada understood clearly that , "we learn about the existence of atoms not through perception but through speculation" , and he provided an example of this speculation : if matter were divisible indefinitely, there would be no qualitative difference between a mountain and a mustard grain, because "the infinite is always equal to the infinite".

It is not known whether Democritus (460-370 BC)was aware of Kanada's philosophy. The English word "atom" came from the Greek word "atomos" meaning "indivisible". This word sounds similar to the Sanskrit word "atma"(which means "self" or "soul") and refers to the non-physical conscious energy indivisible and un-destroyable. Ancient science may it be Indian or Greek did not create a true technology because it had not elaborated physics. It started with applying geometry to the reality but the daily life in the midst of which human beings lived was not mathematical nor even mathematisable. In fact it is an enterprise ever changing, imprecise, more or less of the approximate.

However, the nuclear model of the atom has become the basis of all sciences. A single observation and its correct interpretation led to a revolution in scientific thought unparalleled in the annals of science. The knowledge of the laws of the physical universe is based on the atomic theory. The atom is seen to be a point-source of energy. Different energy levels and vibrations between neighboring atoms give the appearance of form, color and heat. It has been established that the entire material world we see around us as a variety of forms and colors, light and heat, is formed of these point sources of physical energy or atoms. The most beautiful scene in nature is merely a pattern of energy waves and vibrations. The sense organs select the vibrations and relay a message to the mind where all images are formed. The eyes see some of these patterns as light forms and colors, the nose picks up odors. In the same way sounds, tastes and sensations are detected and all of these are transmitted to the mind.

Physics as a science came into existence in the 17^{th} century and quickly replaced the ancient natural philosophy. This new science was based on experiments and mathematics rather than on pure speculation. Forgotten idea of Democritus was resurrected by Pierre Gassendi (1592-1655) of France, Robert Brown(1773-1858) of Scotland , John Dalton(1766-1844) of England. Then it was Max Karl Ernst Ludwig Plank(1858-1947) who on 14^{th} Dec 1900 presented before the German Physical Society on the quantum and very few people realized that day the grandeur of the moment. Later this idea became the stepping stone to unravel the enigma of the microcosm by the help of what we call Plank's constant(h). Interestingly French Academy of Sciences sent astronomer Cesar Janssen (1824-1907) to India for observing the spectrum during total solar eclipse on 18^{th} August 1868 where he discovered a mysterious yellow line later to be identified as element Helium and in 1895 its presence on earth was discovered by William Ramsay(1852-1916).

History of physics is not merely a compendium of facts, random collection of formulas and concepts. Truths emerging from physics are only productive when they are interrelated and when these relationships can be traced throughout their evolution. Degree of corroboration is a very important aspect of any scientific theory. The manner ,in which a theory has passed and not passed its tests, including the severity of the tests, tests undertaken in a critical spirit, attempted refutations etc should also count. By passing through such rigour a theory may prove "its mettle" and "fitness to survive". The degree of corroboration of a theory is a rational guide to practice. Although we cannot justify a theory, that is, justify our belief in its truth—we can justify our preference our preference of one theory another, for example if its degree of corroboration is greater. Einstein's theory was preferable to Newton's, by showing that its degree of corroboration is greater. Just like an organism "fitness" means survival , and past performance in no way ensures future success, it is equally true for a theory. It has been rightly said that in the history of mankind our main concerns are not the names of rulers or dates of their reign but the birth, rise and decline of civilizations, the evolution and substance of ideas, which have for ages directed the will of people. During the time span 1858 to 1902 , Planck, Rutherford, Einstein, Max Born, Niels Bohr, Schrodinger, de Broglie, Heisenberg, Dirac were born and with their separation during the time span 1947 to 1987 an illustrious phase of physics was concluded and the new era is yet to usher.

HUP,BT&QM:

Werner Heisenberg while speaking to Fritjof Capra once told that , "Indian spiritual tradition recognizes relativity, interconnectedness and impermanence as fundamental aspects of physical reality. You and I are physicists of different kind". At the most fundamental level Heisenberg's Uncertainty Principle(HUP) is a measure of the unity and interrelatedness of the universe. Einstein's observation in this regard is quite apt, "As far as the laws of mathematics refer to reality they are not certain , and as far as they are certain they do not refer to reality".

Geoffrey Chew's Bootstrap theory(BT) is a radical break with entire western approach to fundamental science. According to this hypothesis nature cannot be reduced to fundamental building blocks of matter but has to be understood entirely through self-consistency . In BT every particle is related to the other and also to itself which makes the mathematical formalism highly non-linear.

Things exist by virtue of their mutually consistent relationships and all of physics has to follow uniquely from the requirement that its components be consistent with one another and with themselves. It has strong parallels with Mahayana Buddhism. Reduction of nature to fundamentals is basically a Greek attitude whereas the view of universe as a web of relationships is characteristic of eastern thought. Beauty is the proper conformity of the parts to one another and to the whole.

BT abandons the fundamental idea of building blocks of matter but accepts no fundamental entities whatsoever—no equations, constants, laws. The material universe is seen as a dynamic web of inter-related events. None of the properties of the any part of this web is fundamental; they all follow from the properties of the other parts, and the overall consistency of their inter-relations determines, the structure of the entire world. Heisenberg strongly believed on a fundamental equation (World Formula) from which the structure of the elementary particles could be derived . But contrary to this belief Chew found the characteristics of quarks without presuming the physical existence of quarks.

In BT physical reality is described in terms of isolated events that are usually connected but are not imbedded in continuous space-time. Space-time is introduced macroscopically in connection with experimental apparatus but there is no implication of a microscopic space-time continuum. Absence of space-time continuum at microcosm is perhaps the most radical aspect of Chew's BT for physicists and layman as well. A physicist who is able to view any number of different, partially successful models without favouritism is automatically a bootstrapper.

Interestingly Heisenberg, Bohr, Schrodinger, Bohm were influenced by philosophy especially of Kierkegaard, Plato and Upanishads but Chew was not. He was deeply influenced by Enrico Fermi who was a pragmatist and not at all interested in philosophy. His line of thinking matched with Arthur Koestler who said that every creative act involves...a new innocence of perception, liberated from the cataract of accepted belief.

For centuries philosophers have argued over the existence of distinct substances. Quantum Mechanics (QM) has settled the question for good: there is only one substance. To begin with, nothing in the formalism of QM refers to the *shape* of an object .Seemingly harmless expression as "possessed position" is seriously misleading, in as much as it suggests the existence of a multitude of position-possessing substances. There is only the substance that warrants the existence of positions, and this is the same for all existing ("possessed") positions. Hence there is no such thing as empty space—not because space is "filled with vacuum fluctuations", as some say, but because there are no unoccupied locations or un-possessed positions.

At present, the physics community is believed to be in three categories:

- The first—the majority—doesn't care much of what quantum mechanics(QM)is trying to tell us about the nature of Nature.
- The second resigns itself to agnosticism asserting that we cannot describe the quantum world fully its features are forever beyond our ken. All we can usefully talk about is statistical correlations .
- The third accepts the quantum world as it is, independent of measurements.

Agnostics and others have a point and both are wrong. The agnostics have a point in that nothing of relevance can be said without reference to measurements. They are wrong in claiming that the features of the quantum world are beyond our ken. Others have a point in that it is indeed possible to describe the features of the quantum world. They are wrong in claiming quantum features can be described without reference to measurements.

Science is driven by the desire to know how things really are. It owes its immense success in large measure to its powerful "sustaining myth" the belief that this can be discovered. If today we seem to have reason to question our "sustaining myth", it ought to be taken as a sign that we are once again making the wrong assumptions.

QM is a rare piece of human knowledge, one that is held in special esteem in the 20th century. We should remember, however, that this is just a small, although exceedingly important, part of the general human culture, and it is only in this context that we can understand its true place and role in the evolution of modern civilization .George Bernard Shaw said in his characteristic brilliance, " humanity is bewitched by the advance of science and art alone is capable of bringing it back to reality".

Unfinished agenda:

Observation of phenomenon, sense of wonder , attempt to explain the phenomenon through probing questions is nothing but scientific enquiry. Questioning continues to be the fundamental activity of any scientific enquiry which compels to put the fundamentals in the dock. Questioning is never ending. Schrodinger was once asked, "what is the characteristic feature of life ? When is a piece of matter is said to be alive?" To these probing questions he gave a reply, "It is by avoiding the rapid decay into the inert state of equilibrium that a organism appears so enigmatic...Thus the device by which an organism maintains itself stationary at a fairly high level of orderliness really consists of continually sucking orderliness from its environment".

George Bernard Shaw was not wrong when he said in his inimitable way, "Science is always wrong. It never solves a problem without raising ten more problems". Still man shall

surpass himself and the scientific paradigm created by him because we are aware of the fact that :

- The quest of science is never ending.
- Imagining the future of science is prone to naivity, weirdness and overstatement.
- There are exceptions of science but it is next to impossible to predict the potentialities of science.
- The world of compact micro machines, may be controlled by man or may not be.
- Scientific mode of thinking is one of the rarest faculties available to human species and man will one daydiscover in himself new resources to probe deeper into the unknown recesses and will understand his position in the creation.
- A new ,still more refined knowledge will incorporate all achievements of science and much more , derived fromthe infinite unknown.
- Intuition will be cultivated and the intuitive edge will be ,instead of a means of scientific foresight ,become a tool of scientific proof shedding away the apparatus of logic.
- If man lives in this mortal vale even a thousand centuries he would still never reach perfection in knowledge.
- Theses laid down by rational formulation are not the only possible presuppositions of human reason.
- The passage of physics is from the "known few" to the "unknown vast".

There are no well-defined boundaries between various physical and technological research and development problems, one has only to remember the way in which new "especially important" problems emerge. Mostly they originate, as discoveries do, from the 'grassroots' problems as geniuses are born to normal parents. In other words, many remarkable discoveries and advances in science were unforeseen and unexpected.

Some types of research have industrial and economic links, involve considerable expenditure and so on. Therefore ,development of science is linked to politics, economics, technology, sociology and psychology and has numerous humanitarian implications. These interdependences are very complex, hard to analyze and poorly understood. The consensus contributing to the development of science can be reached only in a constructive debate where the arguments and counterarguments are freely discussed and compared and the truth is, if not arrived at, then at least approximated. Debate on development of science should go on in an atmosphere of tolerance and goodwill. Physicists and leaders of other science disciplines should not forget to write for the general readers which will acquaint them with different views and to make really well-founded conclusions.

Erwin Schrodinger told, "I know not whence I came nor whither I go nor who I am". The chief cause of suffering for the existent is the impossibility of transmitting experience of existence. Quoting the words of Thomas Stearns Eliot :

Where is the Life we have lost in living?

Where is the wisdom we have lost in knowledge?

Where is the knowledge we have lost in information?

People who are weary or disillusioned often feel that the huge body of scientific knowledge , has forgotten its ideals and is bogged down with trivial details and has become a burden crushing the mankind which has created it !

Quintessence of Upanishadic thought is interesting to look from a physicist's angle:

I am absolute, so are you (aham brahmashmi, tattwamasi)

That which is in the microcosm is also in the macrocosm(yatpinde tatbrahmande)

Truth is subtler than the subtlest and larger than the largest(anoraniyan, mahatomahiyan)

It is not untrue to say that modern physics does not originate from earth alone; it comes from the space(skies) and it is in the space(skies) that it finds its perfection and end. The language spoken by the spiritual leaders and the physicists are equally abstract and reveal the same truth.

Protagoras said , "As to gods, I have no means to of knowing either that they exist or that they do not exist, for many are the obstacles that impede knowledge, both the obscurity and shortness of life."

Epilogue:

Mankind today is facing multidimensional civilizational crisis which has engulfed almost all aspects of our lives—material and spiritual. All nations, whether rich or poor, are in fact nations with a troubled soul and are in search of a new paradigm. The question is how can science and spirituality reconcile and contribute to making this planet full of love and peace. Indian philosophy answered this question centuries ago by raising food for thought in Mandukya Upanishad, "What is that O'learned, knowing which all the universe of objective experience, both external and internal becomes known"(kasminnu bhagavo vigyante sarvam ida vigyantam bhabati).All therefore must strive for the complete knowledge of absolute truth. Is it hinting at the Grand Equation or the Theory of Everything ?

On 1.11.11 the global population touched 7 billion, and a United Nations study estimates that by the year 2050, there will be 11 billion people living on earth of which 9.5 billion will reside in developing countries. Paul Claudel said, "Before

we change the world, it might be more important not to destroy it." While space has shrunk in time and distance transforming the planet into a global village, one will have to enquire into the real nature of this global village. It is certainly not a homogeneous happy village, where everybody on the planet is assured of a minimal decent quality of life. In this context it becomes extremely necessary to disseminate the essence of science through non-traditional education and popularization of science.

Rapid developments in silicon technology, computers, power sources and inertial systems have resulted in substantial reduction in weight of satellites from mini satellites(500kg) through nano satellites(10kg) to what is called femto satellites (weighing only a few grams/micrograms) which can be launched in tens of thousands as a swarm of mosquitoes!

Similarly with the information being generated at 200 trillion bits a day, one necessarily needs info on info for which counties have already started info-infrastructure are being at national and global level for their own existential survival. Information and data base have become the modern encyclopaedia.

Last two decades have a thrust area on Global Positioning System(GPS) and the concept of free flight ,the dream of any aeronautical engineer is soon going to take off. With the collision avoidance technology the flight commander will choose his flight path without depending on traffic control. This will be error free and the optimal flight path will also reduce aviation fuel cost.

Everything is not well in space. The geostationary arc at 36,000 km above equator where the satellites operate is in great demand. Countries do not get a slot. Demarcation between air space or the delimitation of space .The space debris problem has become serious hazard because from the millions of space debris dispersed in space 40,000 objects (each larger than 10 cm and moving with a velocity of 8km per second) have been tracked. It is a challenge for the space physicists.

As an off beat measure it is refreshing to know that Moscow Institute of Physics & Technology has a Chair of Problems in Physics & Astrophysics where current problems in physics as a whole are discussed and multidisciplinary areas like chemical physics, biophysics, geophysics, physics of metals are re-looked. However, any selection of "especially interesting and important problems" tends to be arbitrary. The problem would cease to exist also if it is proved to be insoluble.

It is true that physics has taken its stand on the firm ground of experiment but has lost its aspects of serene wisdom and leisurely contemplation. We can lament over this but hardly change anything. Not all things by far can be broken down into elements and described in mathematical terms. We should not grieve over this, however. This simply means that our world is more varied and complex than the image provided by physics in particular and science in general. The might of physics lies in its universality. Its laws are free of the arbitrariness of people, it only represents their collective experience , independent of age, nationality or fame of mind. The secret of art ,however, is its inimitability.

Physics was thorough and unhurried; it kept on solving its problems for years and many of them passed over from generation to generation. It could afford this luxury because of an unambiguous method that was devised to recording and storing the facts established by it. But in recent times the subtleties of art has entered into the precincts of physics to have the fruits of split second perception in a hurried world through microchips, nano-technology electronics. Yet there are virgin areas like extra-sensory perception(ESP), parapsychology, meditation, death , immortality , consciousness, strange behavior of animals before calamities etc. where exploration on the part of physicists is awaited

Just by the click of finger the world website is spread out in front of eyes and the system is open for information , scrutiny and further improvement. Human being has reached a precipice of knowledge which is powerful enough to transcend himself. This is possible because the creative aspect of all arts and science is the same. It is determined by one's intuitive capacity to group facts and impressions of the surrounding world so as to satisfy our emotional need for harmony, a feeling one experiences when out of the chaos of external impressions one has worked up something simple and consummate, e.g. a statue out of a marble, a poem out of myriad words , or a formula out of numbers. This emotional satisfaction is also the first criterion of the truth of the product, which is of course is to be tested later on –by experiments in science and by time in art.

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GRIEVE NOT ... GREET IT GRACEFULLY

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Man represents the highest form of biological evolution in multicellular organisms. The special biological attributes which make man unique are precisely three. Firstly, he possesses a highly evolved central nervous system capable of ordering the many sensory impressions embellishing life : human brain can predict important aspects of the future and create or invent means for dealing with new or anticipated problems adequately. Secondly, man possesses a motivational – emotional machinery which records and colours his life internally with special heights of joy or sorrow, anger or fear, hope or despair : it is this quality which has served to civilize men. Abstract reason alone, makes machines, not men. Thirdly, the human species possesses a lifespan long enough to record and order the billions of experiences that he encounters. Great longevity gives him scope to act wisely on the predictions of the central nervous system. Despite all this, it is a fine irony that man has yet not unraveled the scientific basis of his own impermanence. Naturally, death and its forerunner aging, still appear to him as a riddle, wrapped in a mysterious enigma to which, he either turns a blind eye or acquiesces calmly.

Myths and magic dominated most of the past generations of mankind. Myths about racial differences, myths about national qualities, myths about magical escapes from personal difficulty still enjoy wide popular acceptance. Many of these myths are harmless, or at worst neutral in their effects. But mythology about that most inevitable of all personal events – death – and its forerunner – aging – still beclouds a scientific attack on the problem or human aging.

It is now well established that living organisms, including man, are enormously intricate machines. Man-made machines, as we all know, are collections of matter, which, on account of their orderly structures, are able to do work – that is, they create order or unusual arrangements of things by using the energy available in their environments. But all machines possess one feature in common. They tend to deteriorate with time and use. Such spontaneous deterioration of machines reflects the third law of thermodynamics, which states that all organized systems shall tend to move towards more disordered states with the passage of time. Rust accumulates, bearings erode, plumbings degenerate and light bulbs and television tubes burn out. There can possibly be exceptions to the above general rule. Any machine which is so constructed that it will repair or replace all of its parts at least as fast as they deteriorate, can probably last for an indefinite period of time. But alas ! such a machine has never been made. Considered from this angle, the nature-made biological machines – that is the human beings – are more efficient and more durable machines in so far as they are capable of repairing and replenishing on their own, atleast some of the parts that fail. The pity is that some other vital parts of the biological machine are not at all repairable or replaceable. Hence, biological machines, as much like the man-made machines, are apt to age and decay at some point of time. So, it appears that the decay and deterioration of the nonreplenishing parts of our body is the central cause of aging. In other words, aging is the inevitable fate of all multicellular organisms. Old age, followed by death has been so accepted a fact of life that no serious efforts have been made by scientists till recently, to study its biogenesis. Till date, neither the duration of youthful life nor the maximum life span has been prolonged, though only the average life span has increased.

It is seen that the life span of an animal divides into two phases ... growth and senescence. The early phase of growth is a fast process leading to maturity. Growth continues even after maturity, but its rate is slowered down till the fully grown adult between 20 to 25 years of age. Most of the functions reach peak activity at this stage. This is followed by senescence when various functions begin to decline, the rate of decrease of each function increasing with advancing age. The life span of an animal is in a way analogus to the path taken by a javeline when it is thrown upwards at an acute angle. Its speed is greater initially; gradually decreases as it goes higher; then it moves at the highest level for some distance whereafter, it starts falling downwards, increasing in speed as it nears the ground. Some gerontologists are of opinion that about 1% of the functions the humans have at age 30 is lost for every year of life thereafter. A few functions, however, deteriorate more slowly, a few more rapidly, but this rate of decrease is the general rule. The decline in ability to function produces two effects : the first is an increased susceptibility to illness of various kinds; the second effect is a greatly increased

chance of dying as age advances. If we could retain the vigour and verve we possessed at age 15, we would live for an average of 10,000 years. Were it not for aging, we could still talk with some of Alexander's compatriots or discuss religion and philosophy with some of the original disciples of Budha, Jesus or Socrates. About a century ago, an English Insurance Actuary, Benzamin Gompertz, described a simple rule for the increased rate of mortality with increasing age. He propounded that the probability of dying doubles about every 7 years for man. This law also applies to lower forms of animals, but the time required for doubling of the force of mortality in their case, is much shorter, from a few days to a few months.

It is therefore pertinent that we should not grieve over our graying hair, loosened teeth, sagging skin and wrinkled face which herald the sure foot-prints of aging. Aging of human and other living things are inevitable and certain. It results from the failure of systems to utilise some of the genetic blue prints to replace structures lost by attrition. To the extent that the primary genetic decoders which are responsible for this, can be reinstituted at some point of time in future, let us hope that it may be possible to alter or reverse the course of aging. Whether and when this will be achieved depends on the talents and resources expended for this purpose. Till then, grieve not - greet the grandeur of old age gracefully.

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SCIENCE, SCIENTISTS AND SOCIETY

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On April 5, 2009, L' Aquila in Italy suffered an earthquake. Over 300 people died and there was huge damage to property. For this, several citizens have sued a group of seven scientists for manslaughter.

These scientists were seismologists. They were not responsible for the quake as the earthquake cannot be predicted. But they were persistently advising people to remain calm and not to worry. Two members of the group even held a press conference along with the city mayor and said that the seismic situation was normal and posed no problem.

The prosecutors expected that those seismologists should have told the people that seismic prediction was uncertain instead of claiming no danger.

Here is a live example of engagement of science with society. The prosecutors firmly contended that the suit was not against *Science* but against the *Scientists* who had acted in an irresponsible manner. If scientists fail in their duties and commitment towards the society, the society has every right to condemn the community of scientists.

The scientists would have to act in a manner which is not detrimental to human life. The *Russel – Einstein Manifesto, 1955* called upon the scientific community – "Remember your humanity and forget the rest. If you can do so, the path lies open to a new paradise; if you cannot, there lies before you the risk of universal death."

Of course, adhering to social responsibility is not without risk. Iraqi scientist Dr. Hussain Al Saristani had to undergo 11 years of imprisonment for refusing to work on Saddam Hussein's weapon programme. Similarly, Dr. Jeffery Wigand lost his job. His wife and children left him – the price he paid for not towing the line of his employer and standing firm in his commitment to society. The History of Science is replete with many such similar tales.

Although society is gradually becoming more and more dependent on modern science, there is an ever widening chasm between Science and Society. Scientists are partly to blame for this situation, for they too often remain aloof from the rest of the society and ignore social issues. They should not always yield to the dictates of the politicians. Rather, they have a moral obligation to appraise the policy- makers about the problems and dangers involved in any scientific operation. On no account should they sacrifice the ethical principles of science.

Science has been defined as a 'Systematized body of Knowledge'. Hence, there is nothing like a 'good' science or a 'bad' science. For, example, it is good in peace and bad in war. Good or bad in case of science is viewed in the context of its application and the impact of the particular application on the society. Since the state of the society is to a very great extent influenced by science, the modern civilization can be termed as a scientific civilization.

It may be said that 'Science is of the people, by the people and for the people.' In other words, 'Science is of the society, by the society and for the society.' Therefore, science ought to be social and universal. Eminent scientist Homi Jehangir Bhabha had said, "The problem of establishing science as a live and vital force of society is an inseparable part of the problem for transforming our industrially underdeveloped country to a developed one."

Science may not mould the society, but society has to keep science in its place. Because scientific community does not exist in vaccum and is therefore not socially autonomous.

Rifchie Calder, the British journalist and author was of the opinion that science and society are not independent of each other. In her words, "Science helps to create social conditions; social conditions recharge the accumulation of science."

We often talk of the abuse and misuse of science. But the so-called evils of science are not handiwork of science, but of a few scientists who fall prey to the pressures of the politicians. The twin explosion on Hiroshima and Nagasaki are testimony to the unholy collusion of scientists and politicians leading to a mass annihilation of mankind. Society has been enjoying the fruits of science day in and day out. But it has always been in anxiety and fear of the weapons of mass destruction. If any scientific discovery becomes the cause of mass-scale massacre, scientists become a threat to the civilization, rather than emerging as saviour of the society. Therefore, Science should always be used as a 'good servant' and not as a 'bad master' of the society.

The present society is far different from what it was about a hundred years ago. There has been a lot of evolution and revolution. There was a time when human habitation was confined to isolated pockets. Social norms, practices and disciplines were limited to that isolated society. But, now science has smashed the barriers between different segments of the society and has ushered in a universal brotherhood. It is for Science alone, that the concept of 'One world, One Government' concept is gaining firm ground. Science has made the world smaller and the society more permeable and interacting.

Science is gradually weeding out a lot of social, economic and political ills from the society. Scientists are joining hands with the sociologists to further the cause of world peace. Their concerted efforts are aimed at improving the state of the common man.

Mr. Luther, an eminent thinker has rightly said, "Neither peace, nor freedom can be made secure in a world of nuclear giants and moral pigmies." Hence, scientists must be aware that they have a solid social commitment. They are in a great measure responsible for all round improvement of the society of which they are a part.

It is the *people*, who provide funds for scientific research. Therefore, it is the bounden duty of the scientists to repay their debt to the society. If any of their scientific work goes against the society or the people at large, it might be viewed as an act of treachery.

Famous British novelist and famous writer of scientific fictions, H.G Wells said,

"Modern Science is a strange paradox. On one side, it has opened up a vista of celestial blessings and comforts on earth having conquered time, distance and space, thereby translating 'impossibility' into 'possibility' – while on the other hand, it has degraded man to the basest degree – having made him a brute of the most formidable type."

Science is a 'faithful servant', but a 'tyrant master'. As long as it remains a faithful ally of man, society is safe. When it emerges as tyrant, society is degraded and devastated. But, *Science* per se, is not to be blamed for it; it is the man behind science, i.e., the scientists are in fact responsible to bring science to disrepute.

Science is the noblest attribute of nature. But when it falls into the hands of unwise politicians and subservient scientists, science is misused. If inventions and discoveries are used without conscience, it is likely to send the humanity to its doom and society to perish.

Former President of India, Late Dr. Rajendra Prasad had observed that "Without taking a moral view of life, we cannot properly use the inventions of science for the welfare of humanity. Therefore, the scientists are required to be the saviours of society and not its destroyers. They should boldly oppose the politicians and convey the message that under no circumstances will they allow their discoveries to be used for the destruction of human life and the deterioration of society."

Present day society is not in a happy state; not in peace. It is always under the threat of violence and war. This has happened because man has evolved only biologically, but not psychologically. He has not been able to elevate the level of his conscience to a higher pedestal. He possesses no adequate wisdom, no conscience, no concern for his fellow men and no compassion or brotherhood.

If the scientists have no conscience or morality, and if the society is not benefitted by their acts and attitude, what is the use of their scientific knowledge? They may claim to be very much advanced in respect of their scientific knowledge, but in respect of their psychological development, they may be termed as savage and primitive.

Science and science-based knowledge do not trade in values. Science itself cannot decide what is 'right' or what is 'wrong'. It does not make a scientist 'responsible' or 'irresponsible'. It means, Science is independent of values. But to discover scientific values from science is the moral responsibility of the scientists.

In fact, the scientific spirit is the most valued discovery in science. The scientists, who do not inculcate the scientific spirit, will never be truthful to science and society. If this spirit is sacrificed, then the valued aims and objectives of science are sacrificed. Unless science and scientists become society-friendly, all the research, inventions and discoveries are of least consequence to the society.

American Science Journalist and author Natalie Angier and American biologist Thomas Eisner have rightly claimed that, "Scientific discoveries do not belong to scientists alone. They are the heritage of all."

In order to bridge the gap between science and scientists at one end, and society at the other, science socialization is imperative. Scientific understanding being a cultural necessity, it needs to be socialized and humanized.

People in general have a morbid fear for science. Their fear is not at all unfounded. They invariably think that science is a very difficult subject, which cannot be easily understood. They further feel that one should be very intelligent and highly educated to comprehend the nuances of science. In fact, in many of the science writings, there are liberal use of difficult scientific terminologies. It is therefore natural, that the readers will withdraw themselves from going through those articles.

Hence, in order to make it popular and reader-friendly, science articles should be brief, simple and lucid. Topics covered must be need-based. The topics on Health, Environment, Climatology, Agriculture and Animal & Husbandry have a direct bearing on the general public. Writing on science will not be popular and acceptable to people unless economic, social and individual interests are brought into picture.

Atma Ram, the Famous Indian Chemical Technologist and Science Administrator has stated, "Science must be translated to factories, fields, and homes, so that knowledge gained in science is taken advantage of by common people."

Similarly, *Science Communication* is not the prerogative of scientists alone. One need not be a science degree holder to propagate science messages to popularize it. Anybody who can deliver the scientific facts quite accurately can safely communicate.

Further, the present day compartmentalization of Arts and Science streams must crumble. There should be incorporation of basic scientific topics in the curricula of arts students and vice versa, because, "Art is nothing, but Humanised Science," Gino Severeni told.

Popularisation of Science should not target the lay public alone. The high school and college students, politicians, bureaucrats, policy makers, as well as industrialists must also be the beneficiaries of science communication.

It should be popularized through documentaries, dramas, skits, roadside shows, songs, cartoons and mass media like radio, television and newspapers. Holding seminars, symposia and science exhibitions also help.

In this connection, the British Science Policy Researcher Peter Farago's advice to journalists is noteworthy. He has advised, "It is not sufficient for scientific news to reach the general public; it is also important that the fears, hopes, difficulties and dreams of the public should be conveyed to the scientists in terms, he not only understands, but to which he can functionally react."

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LANGUAGE AND TECHNIQUE' FOR POPULAR WILDLIFE SCIENCE

(Extracts from a first person account of life and experience)

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Simple tools and easy interpretations can help a lot for popularizing science, particularly when it is in the kind that is off the main academics. Here are a few experiences, innovations and lessons under Crocodile Conservation Scheme and Project Tiger which are two nation-wide projects for scientific management of wildlife resource.

Field practices in these projects have largely been successful as the science of Wildlife Conservation has been explained and implemented with appropriate range of field-languages and techniques suitable for various levels. It has been done with (a) the staffs at the grass root level who strive to translate theoretical recommendations into field actions, (b) the local people who understand just the simple ways of the nature that has nurtured their character to use and protect the resources for generations, and (c) the students who wish that the Wildlife Science steers them through a meaningful career. (d) The remaining public at large and the media are reached with the entire package of approaches.

Wildlife Management prescriptions are strongly directed and improved from experience and lessons learnt in the field. At least three other components which keep changing and interacting on each other also determine the course of management activities. These components are the (a) ecological factors influencing the habitat of wildlife species, (b) the changing or adaptive behaviour of wildlife species, and (c) eco-friendly accommodation of the demand and expectations of various anthropogenic elements. All these components have shaped the growth of the science of wildlife management.

Of late I fear, to a certain extent 'Wildlife Management Practices' is digressing away from the realities of requirements in the field. Instead of laying emphasis on indigenous innovations Wildlife Studies and Management are getting studded with experiments and recommendations applicable to wildlife from very different biomes in other parts of the globe. As a result, perhaps the Wildlife Science is heading to become an abstract science that is not a true refection of Indian natural history or wildlife biology. There is an increasing trend for applying techniques that appear to overshadow the management of 'wild living beings'. Modern gadgets and statistical extrapolations should be used for improving interpretations and not as a matter of convenience to replace field rigours. It is misleading and dangerous to get satisfied with answers to everything out of very little field data.

One of the many reasons for this trend is rooted to a kind of infatuation reflected through dependency and over-use of virtual mathematical models. Computers and remote sensors are able to provide choice for studies without hazardous field camping. Another reason is the administrative and financial ease for experimenting in the field such costly products which are results out of scientific and industrial growth in the electronic sectors. These are fine as supplements that are short-lived enthusiasm for adding luster. These shouldn't sacrifice the most established and familiar basics in natural history and wildlife biology.

A Popular Subject

Easily Elicits Public Cooperation

In 1952 the 'Central Board for Wildlife' was constituted as conservation of wildlife is an important, popular and widely advocated subject of importance for human survival. Later, the Board was renamed as the Indian Board for Wildlife (IBWL) and now it is the National Board for Wildlife (NBWL), with parallel Boards at the State level. The members of the Board are drawn from a wide range of public and professional profile. These members need to be told in simple terms what is all happening in the wildlife sector.

In accordance with recommendations of the Board we have celebration of the Wildlife Week, coinciding with the birthday of Mahatma Gandhi. At this time there are publicity through lectures, print and electronic media, film shows, guided nature tours, and essay competitions in schools and colleges. Other activities that popularise and educate different target groups about the Wildlife Science are 'nature clubs' in educational institutions, and the subject of environmental conservation in the syllabus adopted by the NCERT (National Council of Education Research and Training). The University Grants Commission (UGC) recommended for setting up of faculties on wildlife education in selected universities but the curriculum appears to have only a few takers. The North Orissa University runs a self-financing MSc course in Wildlife Conservation and Management.

School Students Are The Most Receptive To Conservation Message

During 1994-1997 we started to conduct a number of 3-days long nature camps in Similipal Tiger Reserve. There were different participant groups,--- the undergraduate students, college faculties, members from the civil society with various professional profiles, and the school students. The purpose was to give a type of once-in-lifetime exposure in the forest, and demonstrate the various wildlife conservation tools and techniques including studying of tracks and signs. The significant lesson for the management was that the High School children constituted the best target group as these were receptive as well as meaningfully responsive.

The language of interaction and the curriculum of a nature camp were very carefully drawn up. Every part of their time during trekking or discussion gave the participants guided orientation and information. The Forest Guards, Foresters, Range Officers and watchers were very enthusiastic during those days when they could share their life and experience in the forest with wildlife. The language for communication of the art and science of wildlife conservation was simple, interesting and adventurous for the staff and their audience. I have seen, some of the children (students) becoming emotional before the staff when it was time for departure from the forest.

Successful Conservation And Research

Go Hand-in-hand

'Successful conservation and research go hand in hand'. That was the dictum of approach in crocodile conservation programme launched in 1974-75, and it showed the approach for other wildlife conservation projects. There were two main conservation projects in India during 1970s and 1980s. The approach for handling research was different in the beginning. Fresh pass outs from Universities were selected for crocodile conservation work. But in Tiger Reserves the Field Directors handled research initially. Later, Research Officers worked under concerned Protected Area managers or the Chief Wildlife Wardens.

The scientific personnel involved in crocodile conservation programme, project tiger and other wildlife conservation activities in situ and ex situ have produced the bulk of information and literature available today about the target species and the activities for conservation and management. Adminisration has come to recognize that research personnel form the assured base for access to information. Most often these research persons carry out most of the interpretation work for a project. Special Projects like that for vulture breeding is awaiting a suitable research person to remain in charge of it.

Grooming Authors Who Work And Write

My professor from University days, Professor B. K. Behura says research is incomplete without a publication. Yes, unless observations are published, a new researcher joining at some later stage wastes days or years in rediscovering what is already known. At this stage come the aspects like authorship of an article or a research paper, and the choice for a journal.

Considering the actual role of a researcher and the need for sustainability of the pursuit for popularization of scientific research, authorship has to be given due consideration. Administrators or technocrats who adorn chairs for supervision need to be open hearted in giving credit. A scientist often works just for the shake of recognition!

I was recently writing my reaction in response to a blog about the not very happy experience for authorship status like first, second, third, etc. in a publication. The contention is bout who will be the first author, and what order should be followed upto the last author. In scientific laboratories some kind of understanding seems to have prevailed. This is not true in non-research organisations, where the principal or prime researcher normally brings into his fold of confidence as many 'authors' as possible. At the end the authorship credit may appear to be a hierarchical testament under the title of the paper.

When it is a management prescription it is, however, a good idea to have that kind of authorship. People who matter get encouraged and also implement its advantages. Nevertheless, I have also noticed that although I have many coauthors during the course of my 36years of research, very seldom have they produced a technical publication even in their next posting. I have a notion that publication potential is everywhere and in every posting of a person.

During Post-Graduation it was training and, therefore, customary to follow the hierarchy or age-seniority in a research paper. I have taken the facts in that spirit. Things were different after MSc. In this context I must pay my tribute to one person– Dr H. R. Bustard, the FAO Consultant in India for Crocodile Conservation programme. The project started during 1970s, and there I started my professional career. Dr Bustard was the field guide and non-official PhD guide for me. He had issued a circular very early about the principle to be followed for authorship of technical papers. If it was equal contribution starting from an idea to experimentation or data collection and writing, the authorship was alphabetical, though Dr Bustard had the alphabetical advantage over me. For other instances, depending on contributions the first authorship was shared among us.

That was a very healthy practice. Other coresearchers were also happy with that. It got flouted when I had to write with (for) others. Yet, I always expected, sometime somewhere somebody should bring my name to the first, or while giving a talk or powerpoint presentation at least used a 'plural term' to indicate that the analysis was done with others in the administrative set up. Very seldom did it happen, if it ever did. That sometimes hurts a field researcher, and it dampens the spirit of continuing the pursuit of writing for popularization of science!

Where Should I Publish My Work!

The year of start, the international stature of the wildlife project and the locations for my field work were such that most of the observations were new and worth reporting or publishing. Out of over 250 write ups by me only about a dozen may be overseas publications. Others are in Indian journals but with overseas circulation. I always exercised my own choice and option for a journal. I have chosen the journal in such a way that the publication reaches the right audience or the right user.

When I am writing about a new technique which field foresters are to use, I choose Indian Forester which reaches all Divisional Forest offices of India and many desks overseas. When it is a biological note on an Indian species I have chosen the Journal of Bombay Natural History or Hornbill. When the observations or discussions have implications in captive management of animals in India I chose the Zoos' Print. A very old time journal is Cheetal published by the Wildlife Preservation Society of India, Dehradun. These are very widely circulated and established journals for wildlife matter. The WWF Newsletters, the IUCN Specialist Group Newsletters and Sanctuary-Asia are some of the other publications for submitting write ups.

In those days, there was no 'impact factor' of a journal, and there was nothing like internet to browse and search. I had to build my own library. For the last four decades I have been carrying bulks of paper wherever I went. I came to know about impact factor when my daughter started publishing her work on nano medicines and discuss with me issues relating to it while selecting a journal for submission of papers. In modern days the 'impact factors' seem to be the basis for judging the scientific status of a scientist.

Inspired, I searched the net for any possible impact factor given to my journals, but no. My journals, although very special in their kind and used by field workers, had nothing like an impact factor. I am not aware, what exactly is the situation today. I cannot comment on medical science research, which has global implications. And the trend is changing in the world of research.

What I drive to say is that present-day wildlife scientists are competing to gather 'impact factors' through publication of their data overseas, but its utility is often lost to actual field level users. Therefore, where field research involves natural history or techniques for sanctuary management, one must not worry where the journal is published or what is it's impact factor; but must think whether the contents of the writing reaches the field staff and field biologist who will benefit from this and shall not spend time in rediscovering what has already been discovered. They should instead carry the work ahead from the point where it is left at that moment. In this respect there should be a mention about the open access journals on the internet these days. These are very good, very quick, available on the net, and perhaps with some impact factors, if some one is bothered about it.

Institution Heads and Administrators who are assessing their wildlife scientists for promotion or a higher scale should not be fussy about the impact factor. Instead mechanisms should be devised to assess usefulness of the research in the field. Unless this is done, wildlife science will have a difficult road for poularisation.

Field-translation Of Professional Lessons From Ingenous Masters

As a fresher in wildlife research I had the first opportunity to listen to Mr. Saroj Raj Choudhury when he explained near a stream along Tikarpada-Purunakote road on how to interpret hooves marks indicating stampede behaviour of a herd of spotted deer. The herd might have heard or sighted a predator, perhaps the tiger. Through that, Mr Choudhury was giving the basic guidance on how a practitioner of wildlife research should remain alert for visual signs as well as smell and sound to make his field studies fruitful and safe.

During my work in the Mahanadi I had nearly six and a half years of field work with the help of Raja Behera and the team comprising his nephew Prafulla and son Amulya. All three were engaged as Gharial Guards at Tikarpada, as a strategy towards demonstrating 'people's involvement in crocodile conservation. Many other experienced persons like Narottam and Shiba joined as Gharial Guards later. All of them were boatmen and fishermen by profession. They were able to negotiate their narrow long wooden boat on the waters of Mahanadi along the downstream or upstream or in high flood with as much ease and comfort as they did it during low waters of winter and summer. I had my first lessons of rowing a boat from Prafulla and Amulya.

More important, from Raja and others I also learnt how to spot and confirm the sighting of a crocodile on water surface or on sand banks. Then, there were training sessions by Dr Bustard on how to eye-estimate the length of crocodiles from a distance.

Those were initiations which kept me water-borne and study crocodiles. Rest of the happenings in my career demonstrated that indeed 'necessity is the mother of invention'. I wanted to judge the size of the crocodile from just the portion of the head that remained surfacing on water or the various kinds of tale telling spoors of a crocodile that had basked on sand banks. Then I devised the methods for size estimation from body spoor. Similarly, was the invention of the technique to individually identify hundreds of crocodiles from their tail-scute colour pattern. These are simple field techniques that keep the science accessible, usable and popular.

Field Techniques Have To Be Comprehensible In Implementation And Interpretation

One of the major scientific activities in wildlife management is census of wildlife species, at least a few indicator or flagship species, which can indicate the condition or happenings in the entire habitat. The results of census attract the attention of the public, media and the concerned administration. Census results form an easy and direct access to the story of performance of the project on species conservation.

Observing wildlife in natural conditions is not easy because wild animals have learnt to avoid threats or disturbances. That is their strategy and adaptation for survival. The task is more difficult when ground vegetation is dense and high. Determining the exact numbers of wild animals is a difficult technical requirement but has to be carried out with man power available within the Forest Department. By conducting the census the staffs get a first hand feel of the status of the animals inhabiting their jurisdiction, and have a sense of belongingness. Therefore, the technique has to be staff-friendly, something which they can understand, implement and interpret.

For every occasion of wildlife census in Similipal, about 25 participants from different parts of the state and a few from other states and even overseas join the staffs as non-official volunteers. They all belong to very different walks of life. They are given orientation training about the method of census and the jungle-etiquettes. They live with Forest Guards or watchers in tree-top machans or Beat-Camps and carry out field work during the entire period of census. Again, some of them come back for analysis and interpretation of data, and drawing of spatial distribution map of the species counted. For tiger and leopard they become conversant in pugmark tracking method and for elephants it is direct sighting.

A few of these participants have chanced into my office after several years and interacted with me. In these years some of them have reached new heights of career excellence but they continue to be passionate as before. They have expressed that the visit they had to Similipal has left a permanent impression in their mind and action. I feel that the level of interactions with them and the quality of data they handled were responsible for such lasting memory. The Science of Wildlife Conservation has to be easy and understandable through simple biological explanations and the application of common logics.

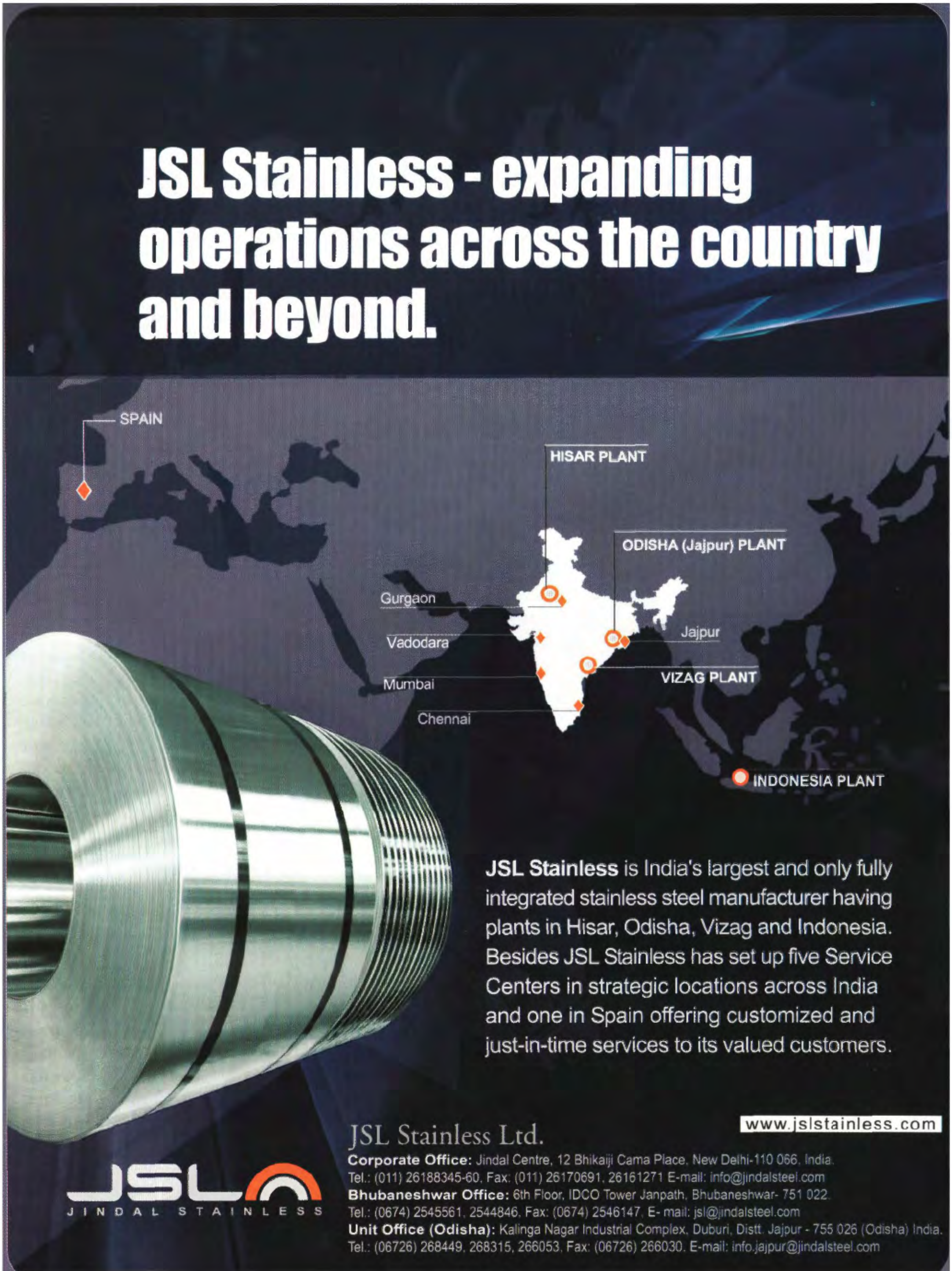
SOME LESSONS AND GUIDELINES

There is no shortcut in Wildlife Science. It has to be backed with full quota of rigorous field exercises carried out locally in the heat or frost, soiled knees or knee-deep humus. While popularising Wildlife Science some of the lessons learnt and that may form recommended guidelines are as follows.

- The staffs of the wildlife organization who implement the project in the field must feel themselves a part of the science that is in practice, and should be able to take pride in explaining the subject and the related activities hey are doing. These staffs include grass root level persons like the Forest Guards as well as Research Scholars who join with career ambitions.
- The people who live within the forest or its fringe who have already contributed a great deal of traditional knowledge, should be comfortable with the new tools and participate in various management actions directly or indirectly, with a sense of belongingness.
- The spectra of administrators, intelligentsia in the society, public representatives, media persons and other stake-holding organizations, who too play a substantial role in sustenance of pursuits linked with 'Wildlife Science' must understand the language of the science and be able to convincingly explain these to others in apropos of their own activities.
- In order to achieve the above objectives the Wildlife Conservation Project should have effective monitoring mechanisms.

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SPACE TECHNOLOGIES IN THE SERVICE OF MANKIND

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Whenever we talk of space and space exploration,we immediately have a feel of very costly work in our minds which involves million and billion of dollars of expenditure.At the same time we are also confronted with another question and it is that when we have so many other problems here on earth,what is the use of going to space and spending lot of money on space exploration.But this type of question have come up because of unawareness among the common people about space and what space has given to man till date.It is true that space exploration is a costly affair but secondary uses of space technologies(called space spinoffs whose numbers have exceeded 30,000) have provided numerous benefits to man on earth and space technologies have drastically changed the life style and living standard of man on earth.As an example the scene of medical field of the world would not have been the same what it is today without the use of space technologies.

Modern time is called Space Age and space has given to man many things which have increased the quality and standard of man's daily life.In our daily life,the technologies developed for space and space exploration have played a very important role in modern society.It is a big list and the list is getting expanded regularly.Here we will be summarizing these various contribution of space technologies which have benefited the mankind so much.

1.Satellite communication technology

Satellite communication(SATCOM) is the most powerful means of communication in modern era.Three communication satellites in geosynchronous orbit (36,000 Km from earth)can establish the communication on the entire globe without problems lik installation,maintenance ,new route extension or any other similar problems which are quite acute in case of optical fibre, communication microwave communication,coaxial cable communication etc.SATCOM is not affected by weather conditions and don't consume lot of time during installation,fault correction and starting a new service.SATCOM has played its key role in the filed of global communication but in addition to that it has been found very useful in some other areas which are as follows:

a)Telemedicine:It is one of the unique application of space technology in which the patients can consult doctors and spaecialists at any hospital in the world and from any location (whether village or unreachable location like mountaneous or foresty areas or a town) irrespective of distance.

b)Distance Education:SATCOM has helped in spreading the education on global level via communication satellites and has given the concept of interactive class room.India's Edusat satellite was also working like that and had been very useful in the field of distance education.

c) Spreading TV services

d) Radio networking

2.Satellite based remote sensing technique

has proved very useful service in the field of agriculture,forestry,finding minerals,water and petroleum products,preserving wild life,monitoring air pollution,mapping of cities etc.

3.Space technologies

have provided a great and significant contribution in the field of disaster management which includes disaster mitigation, disaster preparedness, disaster relief and also disaster rehabilitation.The solutions based on space technology have become an integral part of disaster management activities in many developed and some developing countries.

4.Satellite based search and rescue service

At present there exists an international programme called 'Cospas-Sarsat' via satellites under which if (for example),any aeroplane crashes in a forest,the information within hours is relayed to the concerned country in terms of latitude,longitude and mean sea level of the accident place and accordingly corrective measures are taken.India is also a part of this international programme.Search and rescue service uses satellites in low earth orbit and geosynchronous orbits.

5.Satellite based navigation service

To define a point on on earth's surface,three parameters –latitude,longitude and mean sea level are required and in modern era this information is of great importance in many fields.By satellite based navigation system,a small device

called Global Positioniong System (GPS) receiver can find out these parameters of any point on earth with accuracy of few meters.GPS information is of utmost importance in the field of mobile communication,marine transport and engineering,GIS,search and rescue service,hand held receivers,fishery industry,surveying etc.

6.Medical field

A patient who has spent even a day in a hospital becomes fully aware of the array of equipments which are used to monitor the patient's condition.In this connection it is important to know and realize that most of the patients don't know that needs of astronauts during their space journey and space stay created these technologies.

Various space technologies are at present being used extensively in medical field.Pacemaker being used by heart patients was actually not developed for medical field but for monitoring the health of space probes and satellites from earth.CT Scan and MRI technologies were never developed for medical field but for taking the detailed photographs of moon's surface during Apollo project.Dialysis machines were not developed for kidney patients but for removing waste materials from used water during Apollo mission to make it drinkable.The technology developed for monitoring the changes in earth atmosphere is being used in the early detection of breast cancer. Based on the tehnology of turbo pump of space shuttle, a miniaturized ventricular assist pump(heart pup) has been developed by NASA and renowned heart surgeon Dr. Michael DeBakey. This tiny pump is 2-inches long and 1-inch in diameter and weighing less than four ounces.This has been found very useful as a substitute for heart who are waiting for a donor.This can work for 6 months as heart substitute.Below are mentioned some other space technologies which are extensively being used in medical field and hospitas:

a) Coronary artery disease is a very common medical problem of present age and a few years back it was needing a critical surgery.Later on a solution came out with balloon angioplasty using a balloon to open artery.Since 1994 .a less complicated method is being used in which excimer laser beam is being used.This excimer laser beam was developed to study earth's ozone layer.This procedure is called Excimer LASER Angioplasty in which laser beam vaporizes artery blockage.

b) Foam used in space shuttle's external tank(ET) has replaced heavy plaster on patients with bone injury.This foam is also being used for making moulds for artificial limbs.

c) Devices developed for sensing distant objects through infrared radiation sensing technology are now being used as infrared thermometer which can take a person's temperature in less than 2 seconds.

d) Special lighting technology –ie Light Emitting Diode(LED) used in space shuttle for plant growth experiment is being used to perform surgery on patients with brain cancer.This technique has given very promising results.

e) Space composite material-X33 developed by NASA for space exploration is used for making improved obstetrical Forceps with embedded fibre optics.

f) Pill size transmitters developed at NASA's Ames Research Centre are beibg used to monitor fetus condition from inside womb.

g) Chromosome Analysis technology:Various space probes send many pictures to earth which are analysed by a special technique.This technique is now being used to analyze human chromosome from which disease prediction in infants could me made.

h) Various robotic arms developed for Space Shuttle and International Space Station(ISS) have formed a great and extensive use starting from medical field to handling chemical,biological and nuclear materials.These robotic arms are being used in various other fields like physical therapy,rehabilitation,assisted living aids,metrology, short-run manufacturing and entertainment.

k) When space shuttle astronauts return home from space,a special device is used to measure the equilibrium of their body.This device on earth is now being used widely by medical centres to diagnose and treat patients suffering from head injury and central nervous system disorder.

l) An instrument called "Bioreactor" was developed for space shuttle medical research which can provide space environment on earth.This instrument is being used to design therapeutic drugs and antibodies.

m) Metal alloys are used for manufacturing satellites and spacecraft structures.Now these alloys are being used in health care industry also.A special alloy 'Nitnol' is used for making braces.

n) LASIC eye surgery:For docking(ie getting connected in space) space vehicles with space stations ,a tracking device was developed which works on principle of rapidly tracking and correcting small changes.Based on this technology,LASER- assisted eye surgery process has been developed for correcting short and for sightedness and astigmatism.

7.Industrial contributions

Cool suits, which kept the astronauts during Apollo projet comfortable for doing moon walks, are today worn by race car drivers, nuclear reactor technicians, shipyard workers, people with multiple sclerosis and children with a congenital disorder known as hypohidrotic ectodermal dysplasia, which restricts the body's ability to cool itself.Cordless tools are a gift of spae age and today are being used extensively in many areas.Gas detector used in space shuttle is being used in Ford company for producing natural powered cars.Vaccum metallization technique developed for space exploration hardware have given on earth a extensive line of commercial products.Quick fit fasteners(or bolts)is also a gift of space technology.In space,fastening the items is difficult task.For space purposes,special type of fasteners have been developed which can be pushed on,rather than turned on.These fasteners are quick and strong and on earth have found great usage by firefighters,nuclear power plant technicians and other commercial users.Liquid metals were developed as a part of space shuttle research programme under microgravity conditions.These metals act like plastic and are twice as strong as titanium.It is widely used in sports equipment,watches,flash drives,industrial coating and defence and aerospace technologies.

8.Exerise and sports:

Design of today's sports shoes resemble from the shoes used by Apollo astronauts during moon walk.Spiraflex exercise device used in International Space Station for muscular degradation is being used in many health clubs and fitness programmes.A cardio-vascular conditioner which was developed for astronauts during their stay in space have been used to develop physical therapy machines for foot ball teams,sports clinics and rehabilitation centres.

9.Vehicle Tracking System

used in space shuttle is being used on earth for tracking vehicles on earth.This has found a great use in fleet management such as taxi operation,armoured cars etc.

10.Transportation area:

Radial tyre which gives life mileage of 10,000 miles has used the same material which was used in Viking mission parachute.New ,high temperature composite materials have been able to provide better brake lining in trucks,cars etc.Composite materials developed for space applications have been able to provide 30% weight reduction in helicopter and aeroplane industry.Advanced class of lubricants,energy storage systems and new wing design for aerodynamically efficient wing systems of aeroplanes is due to space technology.

11.Water purification systems in cities:

Water purification technology used in Apollo mission is being used in many cities and towns of the world.

12.Solar Power Satellites(SPS):

There is an accute shortage of electricity felt in whole world and SPS are a solution for that.Lot of work is being done in many countries of the world seriously.It is hoped that the day this project becomes successful,the problem of electricity will flee away from world for ever.That day perhaps we will be able to talk that particular power station is of 5000 MW and next power station is of 10,000 MW capacity etc.

13.Flat cable:

The flat cable which came from space age was actually developed to mount on walls and floors of spacecrafts in a very compact way providing the economic use of space and making the aircraft and spacecraft very compact.

14.Digital Signal Processing(DSP)

which was actually developed for remote sensing of earth and its resources by satellites have found a great use in human body imaging techniques including CAT Scan and MRI.There is a very important course running in engineering colleges for students of computer sciences and information technology and this is called 'Digital Signal Processing and Image Processing' and in short it is expressed as DSP.It was basically developed for Apollo project and remote sensing satellites.This technique has found a great use in medical field.Had this technique not been developed,many important processes of medical field like balloon angioplasty,LASER angioplasty,bypass surgery,ocular screening etc would never have been possible.

15.Among the natuaral calamities,

Earthquake is a field which still is a big problem for man.Man is not in a position to predict the arrival of an earthquake in the fashion he predicts about the rain or a storm.But the man has not left the hope and is seriously working on how to predict the earthquakes by the use of satellites moving in space.The basic theme on which this programme is moving is that when earth plates rubs on each other,an infra-red radiation is emitted.The logical reason is still not known why this happens but this is true that this does happen.This infra-red radiation changes the usual magnetic field of earth .This change is of very small magnitude.If a very sensitive magnetometer is placed on a satellite in space, this change in magnetic field can be measured and accordingly it can be predicted that some earthquake is expected to arrive.By putting a Global Positioning System(GPS) onboard

the satellite ,one can find out the area where the earthquake will arrive.This twchnology and concept has already been tested by two experimental satellites-Quakesat-1 of USA and DEMETER of France and the results are quite encouraging.Further work is still going on in this area.

16.Home applications

Vacuum metalizing technology developed for space has produced many home products like insulated outer garments,food packaging etc.Freeze–dried food concept was used first for astronauts in space.Bar coding which is very commonly used at present in departmental stores was basically developed to keep track of components of spacecrafts and satellites.

17.Caring For Oceans and Environment :

Plankton is the bottom food chain which exists in ocean.Scientists have devised a way to check the health of ocean by measuring the amount of glow(fluorescence)given out by plankton.Plankton is sea food for small marine animals.

18.Application of space Technologies in India

In India, prime agency carrying out space research is ISRO(Indian Space Research Organisation). ISRO has made and launched many communication, ,remote sensing, metrological and atmospheric satellites in space and conducted many useful space related experiments.Space technologies have been widely used in our country for national development in the field of education, telemedicine, TV, telecommunication, mobile satellite service,search and rescue service,meteorology,satellite navigation,,disaster management,Village Resource Centre(VRC) and GRAMSAT programme.Under GRAMSAT programme,,communication connectivity is provided at state level connecting state capitals to districts and blocks.Today ISRO Telemedicine network is providing connectivity to 382 hospitals with telemedicine network.INSAT network has spread TV network in the country.Through Village Resource Centres,many space-based services like telemedicine,tele-education and information on natural resources is being provided to villages.So for 355 VRCs have been set up in various states.

19.Aplplications of space technology to astronomy

For astronomical observations,telescopes are used and different astronomical bodies emit different types of radiations.Visible light and radio waves can be detected by the telescopes located on earth but other radiations like infrared,ultraviolet,X-rays and Gamma rays are absorbed by earth's atmosphere so they can not reach the surface of earth.Hence the telescopes of these frequencies are located in space.Till date many telescopes have been established in space and they increased the astronomical observing power to a great extent.Some of the notable space telescopes working in space are Hubble Space Telescope(HST), Herschel space telescope,Chandra X-ray observatory,XMM-Newton telescope,Kepler mission , Fermi Gamma-ray Space Telescope etc.From Hubble Space Telescope,age of universe was found out and the famous collision between planet Jupiter and comet Shoemaker Levy-9 was also photographed by HST.In addition to these,lot of astronomical knowledge we have acquired today is due to space telescopes.

List and description of Figures related to the articles

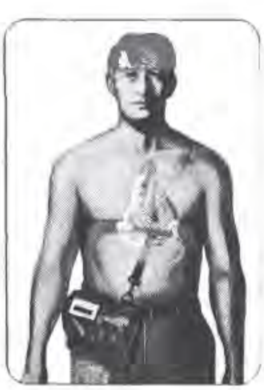


Fig-1:Heart Pump developed from Space Shuttle's Turbo Pump technology



Fig-2:Solar Power Satellite(SPS) is the future hope of large energy source from space under which a satellite with huge solar array collectors will be installed in space at 36,000 Km from earth.

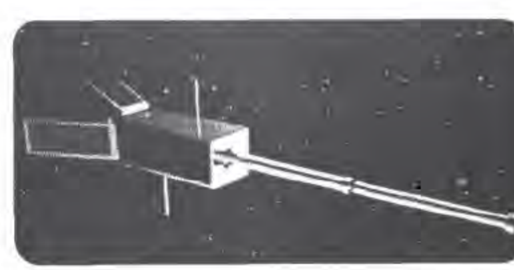


Fig-3:Quakesat-1 satellite was launched in space on experimental basis for detection of earthquakes which gave promising results

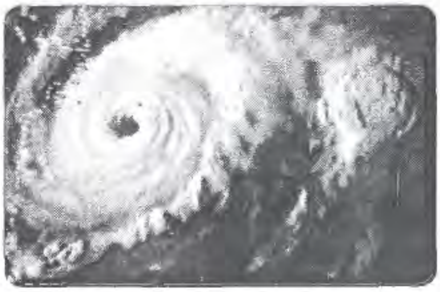


Fig-4:Weather and hurricanes can easily be monitored by satellites



Fig-5:Balance evaluation system developed for Shuttle astronauts



Fig-6:LASER angioplasty system ,a gift from space technology



Fig-7:Cordless tools are another gift from space

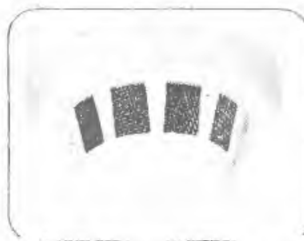


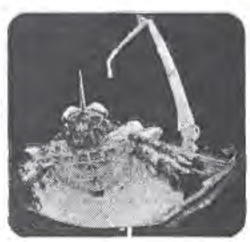
Fig-9:CATSCAN was developed for taking the detailed photographs of monn's surface.It is now the utmost necessity of hospitals



Fig-10:Flat cable was developed for components' wiring inside the spacecrafts and satellites

Fig-11:Robotic Arms developed for space applications have found many other uses on earth

A) Robotic Arm of space shuttle



B) Robotic Arm of International Space Station(ISS)



SCIENCE POPULARIZATION: WAY FORWARD

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Everybody talks about science popularization. There are many government organizations for popularization of science in every country. How far are they successful? For every astronomical event they distribute kits related to the event. Similar thing they do for physics. chemistry, biology, environmental science and so on. This, indeed, generates good atmosphere in the country. But does it generate real spirit of Science? Will it produce great scientists in the country? Very less number of student presently take up science as their career. Where is the problem? What is its solution?

Only science popularization cannot solve the problem. Publishing any kind of magazines cannot serve the purpose. Only lectures or demonstrations cannot serve the purpose. For that, the educator should get clear scientific fundamentals of the young kids. Lectures and demonstrations should be structured in such interesting ways that they include history of the topics, anecdotes of the topics, related examples and stories and principles of the topics which should go with proper visuals in power point presentation. There should be 45 minutes lecture-demonstrations and thereafter 30 minutes question-answer, discussions and interactions. For general public popularization of science should include related stories, anecdotes and proper visual power point presentations making clear some principles of science.

Government or organizations should hire such knowledgeable professional science-educators with proper honorarium. They should be given all expenses towards preparations of such lecture demonstration which will be the property of the government or the organization which finance such projects. These science - educators should go to schools and colleges regularly. There will be three types of science-educators (1) for lower classes of education, (2) for middle classes and (3) for higher classes. Government should include in school – college curricula these activities. There should be working model - making - activity to make clear the fundamentals of students in topic under consideration. Thereafter, students should be asked to debate and discuss and prepare their report individually.

There should be central colleges to prepare such science-educators in every district. After graduation, those who want to be science educators shall join such colleges. There should be graduate and post-graduate degrees in science education.

Science education should be in all Indian languages. There should be regular one day week end seminars in all schools and colleges.

The problem with science – educators to popularize science is of preparing befitting lecture –demonstrations and pictures for such programmes which make them very interesting and effective.

To prepare great students, we should have great teachers. Those who teach just to get salaries should be transferred to the Government offices; only experts, enlightened minds should enter into the education field, first on probation and when they prove themselves upto the mark then, they should be appointed permanently; Until then they should be under observation. Teachers and science educators should be provided all the material they want.

What are other things that qualify such teachers and science – educators (1) Writing popular articles in news papers (2) Making working models befitting to the topics of their specialized subject (3) giving talks on radio (4) giving programmes on TV (5) giving popular lectures in various sections of the society such as Mahila Mandals (Societies of Ladies), in villages, among poor localities, Rotaries and Lions' clubs among senior citizens and among the interested students.

To be a real science – educator many qualifications are required. Firstly, of all he/she should be a hard-core scientist of his/her subject, means, he/she is an expert of his subject who can hardly be challenged by anyone. Secondly, he should be an orator, a story teller, thirdly, he should be a man of imagination and well – versed with preparing proper visuals and should know the history and anecdotes of the subject and know the lives of scientists related with the subject. He should be a writer and demonstrator of high-level. All the more he should be genuinely interested in science popularization in English, Hindi and in his/her own mother tongue. It is very difficult to get such all round science educators. We have to produce such science – educators. To make the country very strong in science – education, this is the need of the time for our country. Our heritage in science is very glorious, wherein, we had Aryabhata,

Bhaskaracharya, Varahmihir, Brahmagupt in mathematics, Rishi Kanad and others in Physics, Nagarjun in chemistry, Shushrut and Charak in Medicine, who were great communicators of science also. We had produced iron pillar which has not rusted for the past 15 centuries. Indians also were the discoverer of zero and numerals 1,2,3,4,5.......9,10 and decimal system. Indian scientists had contributed a lot in the subject like mathematics and physics. Sir C.V. Raman, Satyen Bose, Meghnad Saha, Samanta Chandresekhar of Orisa, Jayant V. Narlikar, Professor Yash Pal, Narendra Sahgal extensively popularized science in our country. We have to produce science communicators of this stature. There are many organizations such as Vigyan Prasar, Marathi Vigyan Parishad, Indian Planetary Society, Amateur Astronomers Association, Khagol Mandal, Bang Vigyan popularizing science in the country. Conferences such as this could contribute significantly in enhancing science popularization in the country.

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NANOTECHNOLOGY:
A FRONTIER VEHICLE FOR DEVELOPMENT

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1. Introduction:

Science is the information about the universal factor as observed and appreciated by human mind. Many of the results of the scientific observations have provided nice facility for living. Naturally available for common living, the soil, water, air and sunlight, which mankind use exhaustively do not remain aware about the importance of such things. In consequence of such happenings the importance of science and technology has to be appreciated and hence it is required that human being should develop awareness about the scientific products they use, sooner the better. Any one who knows science to some extent he/she must also have known that technology is a part and parcel of scientific growth. Hence a wider awareness about science and technology appears to be an important activity on such front. Popularisation of science and technology upto the frontier areas in scientific result is a needed key for contemporary and excellent life management including comfort and development. Nanotechnology being one of the frontier areas has to have its penetration in the mind of every one and there should not be any feeling of extra challenge to push forward this discipline of knowledge in suitable form, faith and format of science popularisation. The following lines are presented to hint about a few important and useful aspects on nanotechnology as would be helpful in common way of living.

Nanotechnology is the study of manipulating matter on an atomic and molecular scale. It deals with developing materials, devices, or other structures possessing at least one dimension sized from 1 to 100 nanometres (10^{-9}). This scale is also described using Quantum Mechanical theory and is on quantum realm scale. It is used for the development of nano-devices for designing molecular self-assembly or replication for nano materials resulting to more wonderful engineering products like nanoscale computers and computing. It has influenced every field of science and technology, be it surface science or organic chemistry or semiconductor physics or microbiology or micro fabrication. Nanotechnology is playing a vital role in its modern form of technology and acceptance in the world. In such nano form the nano materials like colloidal gold, iron, silver and platinum nano-particles posses special features, which nanotechnology utilises for the development of different technological output, as per the need of the present day modern civilization through this revolution leading to a stage of real appreciation and use.

During the last two centuries different revolutions like industrial revolution, agricultural revolution, medical revolution and information technology revolution have taken place. In these revolution the materials used are of bigger scale, but now it has involved the nano sized materials and have tried to influence all these earlier revolutions in a different way which the society will face a new challenging world.

2. What is Nanotechnology:

Nanotechnology is a relatively recent development in scientific research, the development of its central concepts is since 1980, which was due to the experimental advances through scanning tunnelling microscope in 1981 and that of fullerenes in



Fig. 1. Buckminsterfullerene C_{60}, also known as the buckyball, is a representative member of the carbon structures known as fullerenes.

1986. Scanning tunnelling microscope is an instrument for imaging surfaces at atomic level and was developed by Gerd Binning and Heinrich Rohrer at IBM Research Laboratory Zurich and received Nobel Prize in Physics for this invention in 1986,

Fig.2. A close-up of a simple scanning tunnelling microscope head using a platinum-iridium tip.



while, Harry Kroto, Richard Smalley and Robert Curl received Nobel Prize in Chemistry in 1996. In the year 1979 K. Eric Drexler an engineer with multiple expertise, has developed and popularized the concept of nanotechnology and founded the field of molecular nanotechnology. But the term "nanotechnology", was the original concept of Norio Taniguchi, a Semiconductor specialist of Tokyo University of Science who gave the idea of processing of separation, consolidation, and deformation of materials by one atom or one molecule.

3. Scope of Nanotechnology:

In the industry level nanotechnology based efficient computers, nanotech based dress materials, medicines, fertilisers, food preserver, daily used materials for the basic needs like PVC, PE, PET etc, with much better longevity and easy to use due to its nano scale size are the present small output of nanotechnology.

In agriculture nanotechnology based agricultural medicines like insecticides, pesticides, and fertilizer with nano scale effect can help in bringing revolution in the field of agriculture. Nanotechnology enabled sensors with intelligent delivery response systems will help the agricultural industry combat biological viruses and other crop hazards. For waste water management nanotechnology based sand with water proof capability can reduce wastage of water in irrigation if used in deserts.

For energy conservation nanotechnology can help in maintaining a clean and Green environment using nano solar cells. Nano scale energy generation with lighter wind and hydro energy turbines are designed based on nanotechnology. Use of nano-enabled capacitors will create new networks for local electricity storage, which can provide much lower rates of energy wastage and improve performance.

In health besides production of nano level managed medicines, nano scale operation of cells inside the body of a living being can be conducted without bloodshed and direct treatment of cells avoiding much medication and physical bandage. Nanotechnology along with Biotechnology can provide products like "Cell Repairing Machine" which will help to deal with any type of repair or treatment of cells at a nano level by replicating the healthy cells. Nanotech membranes can help in providing Portable water purified with high precision nano-tech membranes with appreciably low cost.

Carbon nanotube (allotropes of Carbon with a cylindrical structure, constructed with length-to-diameter ratio of up to 132,000,000:1), which is one of the outputs of nanotechnology can improve the performance of fuel cells, with cost reduction of catalyst material. Development of efficient transmission devices for nano engineering can have smart devices like smart windows, energy efficient LEDs and wireless controls and also highly efficient conductors and superconductors could replace current transmission facilities. A planned use of nanostructures would make any device power efficient developing power efficient distribution networks. Miniaturized parts like gear and shaft for different mechanical units will create an era in the user level.

In computer and communication nano-computer with nano-chips and nanotechnology inside will be much more powerful and will surpass all the computers of present day world with respect to speed, size and efficiency which is guided by Moores Law.

Nanocomputing is the futuristic application of Nanotechnology as nanoscale device development and theoretical Quantum Computing will lead to such a marvellous development. Nanowire gating geometries and nanowire transistors will lead to the nano device development for nanocomputers. Such type of miniaturized intelligent devices may help in dealing with Medical treatment to work as vehicles to be used for the internal study and treatment even inside blood vessels, heart or other internal body parts without much damage and pain to the patient.

4. Conclusion:

Nanotechnology is certainly working as a frontier vehicle for the development of the civilization in this century. It will change radically the life style of a human being in all levels. Every invention and its rapid growth have their pros and cons. Multiple replication in biological matters and development of nanodevice using nanotechnology, may have some hazardous problem with respect to their control factor. Researching on nanotechnology and utilising their output for the mankind will also have physical and psychological impact. In this regard commercialization may be strictly regulated. It is the responsibility of the scientists, social scientists and users of the technology to take appropriate steps for the convenience without compromising the interest of the mankind. Let this job of popularisation gather strength to deliver upto date strength for all living.

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SCIENCE AND YOGA

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As a student of science, I am in touch with our yoga institute from 1959.It so happens after my retirement from government in 1984, I was working in a Private Company as a consultant. In 1989 I suffered a lot due to depression and insomnia and was addicted to different types of Tranquilizer on doctors advice. These gave temporary relief but pathological features of my system were greatly disturbed and I became very weak. At that point of time my guru, a saintly person came to see me and strongly advised me to keep away from tranquilizers and resort to natural way of living. At that point of time accidentally I met Swami Swarupananda, the mentor of Satyananda Yogashrama of Bhubaneswar. For last twenty-two years I have followed the yogic exercise compatible to my age and has given me a lot of relief. I looked to yoga as a science of maintaining our life system and this has been aptly explained by Swami Satyananda Paramhansa in a discussion held in an Ashram in Sydney some years back. I have felt appropriate to reproduce it as it may bring certain clarity in our understanding Yoga as a science.

In the last century, scientists and leaders in every field taught us that we were living in a world of gross substance. For them, the whole earth was made up of minerals, of gross elements, and man was a compound of flesh, blood and bones. In the scheme of evolution, man stood at the top according to the Drawinian school. That is how everything was set up: society, laws, philosophy, religion, government and also education. They could not penetrate beyond the gross. They could not even accept that there was anything beyond it.

There existed many myths and sayings which related to the subtle aspect of life, but science criticized all their beliefs and views. However, in the last hundred years, science has changed and physics has almost become metaphysics. Now they are talking about the same thing which tantra used to say many thousands of years ago.

The earliest tantric traditions which historians can find from archeological remains in six to seven thousand years old, relating to the Harappa and Mohenjodaro civilizations which existed at the northwestern frontiers of India, in present-day Pakistan. This does not mean that tantra is only five thousand years old. It means that a thriving culture, based on tantric concepts, rituals and philosophy, existed on aprosperous scale at least that long ago, but it is probable that our tantric civilizations existed all over the world, even further back in time, to the beginning of man's existence.

The tantric philosophers who preceded Lord Buddha, Christ, Mohammed and even Moses, Socrates, Aristotle and Plato used to say just one thing, which you should bear in mind. Everything that is visible or invisible is nothing but an expression of shakti or energy. This was the dictum, the conclusive statement made by the tantric philosophers many thousands of years ago.

Today scientists are talking about the same thing in terms of atoms, protons, molecules, electrons, photons, etc. If you arrange them, there is a goat; rearrange them again and there is a man. The external or the gross forms are just different proportions of energy. This is not a joke, but I can't say scientifically, of course, which proportions make a man and which make a goat. That is immaterial, but what is important is that everything, each and every substance in existence, living or not living, moving or not moving, visible or not visible, is a compound of the forces of energy. At the source, everything is the same.

The source of all human beings, animals, insects, vegetables, and minerals, is one and the same. Each and everything has emanated from one nucleus. The entire creation has one nucleus, not two. The whole universe is like a proto-matter, like an egg. One is the positive pole, and the other is the negative pole.

In tantra you call them Shiva and Shakti, and in physics, time and space. Time is one pole and space is another. Time and space are two different dimensions of energy and they have to be united. When time and space come together, they travel from opposite directions towards the centre, and they meet at the nucleus. In physics the nucleus is called the centre of matter, the point from which the object becomes manifest.

Time, space and object are the three aspects of creation or three categories of this universe. Whatever you see- the sun, moon, stars, solar galaxies, constellations, clouds, seas, mountains - is all composed of these three factors: time, space and matter. When time band space meet at the

nucleus of matter, there is an explosion. This explosion throws off millions and trillions of nebulae into the physical universe. These nebulae later become the stars, and your earth is one of those nebulae.

This has been happening in the external world for millions and millions of years and it will continue to happen for eternity. The same thing happens in us when we are practicing concentration and meditation. Meditation is not just a psychological exercise. In meditation, you are handling the energy forces. When you are concentrating on a flame. On a point, on your guru, on a cross, on a Shiva lingam, on your heat centre or eyebrow centre , what is happening is that time and space are coming closer.

Please think about it. What is time and what is space ? You have never thought about it because you have no time to think about time. Time is a concept of the mind and you live within it. It isnot , only gross time, one hour, two hours, three hours. Time is related to object and object is related to time, and both are related to space. Time , space and object are interrelated and that is called creation. Now, our scientists have come to the same conclusion that the whole of creations- the matter, minerals, vegetable kingdom , oxygen, hydrogen, etc., seen and unseen , are nothing but a consequence of the union between time and space, or between the positive and negative poles of energy.

It is a very simple thing to understand. How was I born ? My father and mother met with each other. Nobody can deny this. Is there anybody here who was born without union ? The union between male and female components, between the positive and negative physical components, brought me into existence, brought you into existence, brought everything into existence. Every dig, every donkey, every man, was born through the union between the two opposite poles. Man and women,,male and female, represent two opposite poles of nature and energy. They are not the same. Physically they look the same , except for a few basic differences, but from the point of view energy, they are not the same at all.

Male represents positive energy and female represents negative energy. Therefore , both of them represent time and space and when they meet, in the form of sexual union, in the form of emotional union, they create a connection , a contact between time and space, and creation occurs. This happens with everything in this world - creations is the result of a union of positive and negative forms of energy.

When you meditate, you are creating another union. At the cosmic level, union takes place between time and space. At the human level, union takes place between the male and female. In meditation, union takes place between mind and prana, the mental force and the vita! force. Those two forces in our body are represented by ida and pingala hadis, sun and moon , Shiva and Shakti. In cosmic parlance Shiva and Shakti are responsible for the myriad forms of creation and again in human life, the male is Shiva and the female is Shakti. There union brings us into existence.

It is said that not only the body and mind, this whole vast universe can be turned into energy at any time. Matter is one gross manifestation of energy. We should not see basic differences between matter and energy. Well, I don't have to go to the famous equation of Albert Einstein, E=Mc2. This is a very recent equation, but what I am talking about in tantra is the same thing . the tantric philosophers also believed and said that matter is one state of energy, and energy is one state of evolution of matter.

Therefore, from the scientific and tantric and yogic point of view, we come to understand and realize that we are not just a compound of flesh, blood and bones. Every thought, every action, every feeling is charged with energy. I'm talking into the microphone and you can hear my voice somewhere from the sound box. It is electrically charged. If that is electrically charged, why not my voice also?> How can you say that the voice is nothing but a consequence of friction between one organ and another? This is a very gross explanation. We will have to understand each and every action, expression and thought in terms of this electromagnetic force. Scientists have realized that this atmosphere is not just air. There isan electromagnetic field which connects you and me, everything together. This means that each and every speck of creation is nothing but a matrix of energy, Shakti.

We can call this energy, electron, proton, photon, or anything we like. It makes no difference. We are not just gross emotions; we are not just mud and filth; we are not just a product of the sin of our parents. If my father has gone to my mother, he hasn't committed a sin, and I am not an outcome of sin. I am an outcome of the blossoming of love and the feeling of unity that must have taken place between my parents. If we have this faith in us that we are something more than gross matter born of sin, we can further resolve to transform this physical body into a spiritual substance; it can be done.

They say that Christ went directly to heaven. Many people say it's not possible but I believe it can happen. The body can just disappear. The great lady saint Mirabai, at the time of her death did not lose her body, she did not die as we do. She entered into a temple near Mathura and converted herself into light. The same thing happened to Christ, to Chaitanya Mahaprabhu, and it must have happened to many more saintly people who we hear stories about which seems to be so impossible.If your mind is strongly rooted in the deeper, higher and real self then matter and energy are

not separate substances for you. They are one and the same.

When a scientist looks at matter, he realizes the energy in it. He sees energy in the different elements of which the matters of creation, of existence, of metamorphosis, pf transmigration, etc., but finally it says that everything in this universe is only the formation, reformation, reduction, reorganization and manifestation of one Shakti, and from one nucleus everything is born.

The multiplicity, the diversity, the duality, is in matter, but it is not the basic substance and this is what I have tried to convey to you here. Conventional religions and philosophies have not been able to answer your questions. There are only two basic traditions that can give you an answer. One is modern science and the other is the ancient tantric philosophy

Recently this two traditions have started coming to gather, correlating the facts, agreeing with each other and interpreting each other. Tantra is interpreting science and science is interpreting tantra. The dangers in both are the same. Science can be misused and the practices of tantra, even when they are sincerely and diligently practiced, can be misused and abused. Therefore , side by side with your practices, whatever you are doing, you must try to spiritualize your mind and your life.

MANAGEMENT OF NATURAL RESOURCES FOR SUSTAINABLE HUMAN SOCIETY

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The time of the appearance of human beings is considered as the beginning of a new chapter of activities of the living beings on this planet. The human beings because of their superiority amongst other animals with respect to wisdom, analytical mind and creative ability, from the very beginning started surveying and utilizing the natural resources of the planet like soil, forest, water, minerals, ocean, wild lives and aquatic plants and animals for their better living. With the passage of time they consumed more and more of these resources for various purposes. They began building houses for living, roads and transport systems for communication, growing various types of crops and vegetables on the fertile soil, utilizing water resources and harvesting rain water for domestics and agricultural purposes, mining and utilizing mineral resources to produce various types of metals and alloys for making agricultural implements, weapons for protecting them from their enemies etc. Their efforts for leading a better socio economic life did not cease at this stage rather grew more vigorously with increase in their population, By observing and analyzing various natural phenomenons, they started learning science and technology in order to properly utilize the resources around them. Many a centuries passed before the dawn of modern civilization and industrial developments.

During the last two centuries, particularly the 20th century, science and technology advanced at a very fast rate to meet the growing needs of human beings through utilization of the vast and varied natural resources of the planet. In this process, different types of conflicts amongst various sections of people and two major world wars took place bringing a lot of miseries and ruthless destruction of man and materials on this planet. Science and technology was also used extensively for these destructions even with the invention of the deadly atomic bombs and other nuclear weapons. However, in the modern times, the human beings in different countries have started realizing the danger for using science and technology for such destructive purposes and have created UNO and allied world organizations for their peaceful co-existence and mutual benefits. But, as yet they have not fully realized the consequences of their ruthless and unscientific exploitation of the natural resources and the damage being caused to the environment of the planet. It may be pertinent to highlight the misuse of some of the important resources like minerals, water and forest and their adverse effect on the environment.

Minerals:

At present, with advancement of science and technology, we have learnt the art of mining various types of minerals like coal, oil, iron ore, bauxite, chromite etc. and producing metals, alloys and energy for meeting our growing requirements. But even knowing very well that these resources are non replenishable in nature, we have not cared very much for utilizing these judiciously. The low grade and complex ores and minerals are many times left in the mines to be lost along with the trash materials for all time to come. The mineral based industries like thermal power plants, integrated iron and steel plants, aluminium and other non ferrous metal units etc. due to various reasons fail to apply the environment friendly best available technology (EFBAT) resulting in low efficiency in the production and release of lots of wastes and effluents to the environment. Petrol, diesel and other mineral oils are used extensively most of the time very inefficiently and also causing a lot of pollution on the land and air. However, with increasing use of these mineral resources, it is apprehended that, the time is not far away when our mother earth would be unable to supply these vital resources any more.

During the last half century, extensive mining of ores and minerals and up gradation activities of the low and complex ones, have been disrupting the earth's crust, destroying a lot of vegetations and polluting the land, water bodies and air to a great extent. In addition to these, during utilization of ores and minerals in thermal, metallurgical, chemical, and refractory industries, huge quantities of solid wastes, liquid and gaseous effluents are being generated. Large amounts of tailings and washery slimes produced during upgrading low grade coal, ores of iron, manganese, copper, etc., the fly ash produced during thermal power generation, the red mud generated during alumina production from bauxite, the slags and leached residues produced during metal extraction and many more such activities, disturb considerably the human settlement and also create a lot of environmental problems. For example, nearly 1 ton (T) of fly ash for every 2.5 T of coal consumed in thermal power plant, about 2.5 T of red mud for producing 1 T of aluminium from bauxite and about 200 T of tailings in production of one ton of copper from its ore, are being generated. A list of principal wastes generated in mineral and metallurgical industries, is given in **Table – I**.

Table – I

Principal Wastes Generated in Some Mining & Metallurgical Industries

Type of Industry	Principal wastes generated
Mining	Overburden, Orefines etc.
Mineral beneficiation	Slimes, tailings etc.
Iron and Steel Making	Slags; dusts containing C, Zn, Pb, Cd, etc.; sludges, mill scale containing oil; emission of CO and other gases,
Alumina Production and Aluminum Smelting	Red mud during aluminum oxide production; Emissions from the aluminum production cells containing HF, CF_4, SiF_4, CO, SO_2/SO_3, NO/NO_2 Tar with considerable amounts of polycyclic aromatic hydro -carbons (PAH), dross, spent cathode liners, residues, etc.
Copper Smelting	Slag, SO_2 / SO_3, dust, flue gases containing Cu, Pb, Zn, Cd, As, Hg etc.
Foundry	Flue gases, dusts containing hazardous metals, waste molding sands containing considerable amounts of PAH.
Metal Plating & Finishing	Spent electrolyte, toxic slimes, and heavy metals in the rinse baths, cyanides and other hazardous chemicals.

All over the world, thermal power plant is the single major power producer accounting for about 55% of the total electrical energy generated. In India, nearly 75% of electrical energy is produced from coal fired thermal plants. The estimated thermal power generation, coal consumption and ash generation in India, are given in **Table – II**.

Table – II

Thermal Power Generation, Coal Consumption and Ash Generation in India

Year	1995	2000	2010	2020
Installed Thermal Power Generation Capacity (MW)	54,000	70,000	98,000	137,000
Coal Consumption (Million Tonnes)	200	250	300	380
Ash Generation (Million Tonnes)	75	90	110	140

Most of the coal contains high ash and high volatile matters. Therefore, large quantities of fly ash as well as some amounts of lumpy ash are generated as wastes during combustion of such type of coal in the thermal power plants. With increasing need of electrical energy, the thermal power generation is expected to increase rapidly. As a result, the fly ash generation is expected to go up proportionately. The fine fly ash dust, containing mainly silica along with various toxic matters, pollutes air, water and soil, causing different types of diseases to man and other living beings and also resulting in considerable destruction of forests and cultivable lands.

Water:

The most important substance that has made our life possible on this planet is water. Our planet possesses approximately 1386 million km^3 of water. Nearly 97.5% of this is salt water, available in oceans, seas, salt water lakes and salty aquifers and the rest 2.5% is the fresh water. About 69.5% of the fresh water is present as glacier, snow, ice etc. (24.24 million km^3), 30.1% is available as ground water (10.5 million km^3) and the remaining only 0.4% (13,000 km^3) is available in rivers, lakes, as soil moisture etc. The demand for fresh water for mankind is rapidly increasing because of growth of population as well as development of agricultural activities and industries. Because of mismanagement of this vital resource, in the year 2000, about 500 million people in the world were chronically short of fresh water out of total population of 6 billion, **Figure - 1** shows the percentage of world's population with different water availability in the year 2000. In the year 2050, it is estimated that, the world population will increase to 8.9 billion and out of this 4 billion people may live with water scarcity. At present, the agricultural sector takes the major share of the available fresh water, which is nearly 69%. The industry sector while consumes around 21% of the fresh water, the domestic sector has to be reconciled with the remaining 10%.

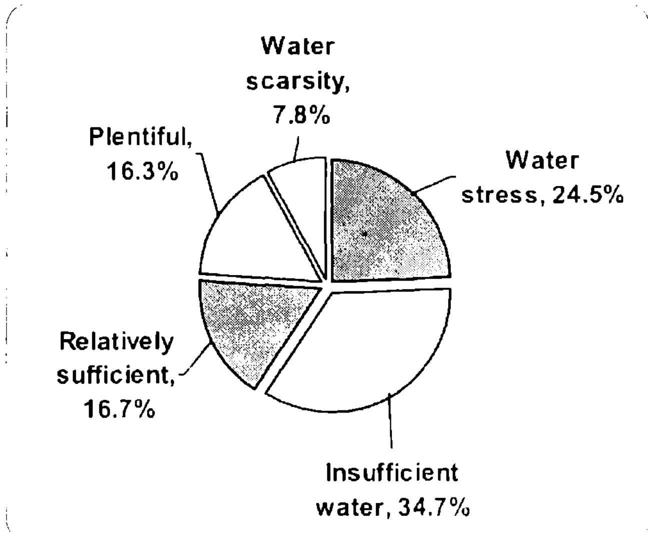


Figure – 1 : Percentage of World's Population with Different Water Availability

In recent years, India is also facing more and more water scarcity with rapid development of industries and urban areas. The per capita water availability during the period 1951 – 2001 has declined from 5177 m^3 to 1820 m^3 per year as shown in **Figure 2**. Due to shortage of water and growth of

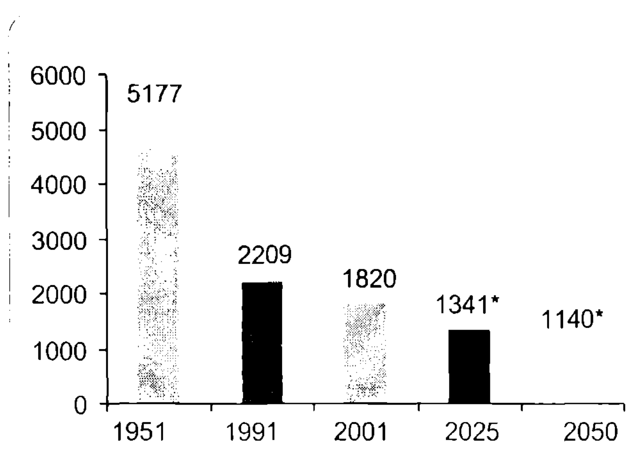


Figure – 2: Per Capita Water Availability in India (In m^3 for Specific Year)

population and increase in socio-economic activities by the year 2050, the availability of fresh water per capita per year would further reduce to only 1140 m^3 unless appropriate measures are taken urgently to increase the freshwater

In recent decades, with rapid increase of human population, industrialization, urbanization, and utilization of higher doses of fertilizers and pesticides in agriculture, water pollution, has caused enormous damage to the living beings in this earth. In most of the developing countries, the rivers adjacent to major towns and cities have been practically turned into open sewers. Industries in the river basins have been continuously feeding the rivers with toxic chemicals without any consideration for the safety of downstream fishes, animals and human beings. Both the surface and groundwater supplies are also progressively getting more and more contaminated by agricultural effluents. On the other hand, massive irrigation has turned billions of hectares into waterlogged and salinized land. Deforestation has bared hillsides, leading to more frequent and serious flash floods in downstream regions.

An appreciable proportion of the fertilizers and pesticides that are used in agriculture ultimately run off into rivers and lakes, penetrate into the soil, and thus heavily contaminate the water we drink. The phosphates and nitrates which are used to promote agricultural production cause disastrous effects, leading to an abundance of oxygen-hungry algae and weeds, depriving fish and other aquatic life the oxygen which is essential for their survival.

In most countries, particularly in developing ones, nearly 70% of industrial waste is dumped untreated into water bodies, resulting in heavy pollution in both surface and groundwater sources. The toxic substances discharged by the industries into water bodies also include the organic pollutants. It has been estimated that, 300 – 500 million tons of heavy metals, solvents, toxic sludge, and other wastes accumulate in water sources of the planet each year due to industrial activities. These pollutants consume vital oxygen present in water and in return inject heavy metals such as lead, cadmium, and mercury, and some of the most dangerous organic and inorganic chemicals. The persistent organic pollutants (POPs) are a group of carbon based chemicals with a number of very harmful characteristics. They all persist in the water bodies for a long period, concentrate on the food chain, travel long distances and ultimately result serious health hazards.

The large amount of solid wastes and liquid effluents generated from human settlement both in rural and urban areas, are released to the water bodies in addition to those from industrial and agricultural sectors. The safe disposal of human waste is equally in a lamentable state. Most of these wastes, including those from sewage and toilets, are dumped into the rivers, lakes, and seas. The developing countries, as well as some of the developed ones, have the standard practice of letting these out to major rivers, without treatment. Over 35% of world's population is still

living with inadequate sanitation facilities. The safe disposal of human feces is a key factor in the fight against many infectious diseases. The untreated sewage being let out to water bodies is the major cause of such health problem.

As we know, dirty water kills, and it happens in a massive scale on our planet. As much as 80% of all illness in developing countries is water related common diseases including diarrhea, malaria, cholera, typhoid, dengue fever, Guinea, trachoma, etc. In developing countries, nearly 4 million people are affected by diarrhea each year, most of them children, and many of them die as a result of dehydration. In the year 2000, the total death in the world attributed to use of dirty water, was as high as 1.724 million.

Forest:

Indiscriminate and rapid deforestation as a single activity has created maximum amount of multiple problems for human beings on this planet. Forests play a very significant role in controlling the amounts of important elements like carbon, nitrogen and oxygen in the atmosphere. While acting as a sink for atmospheric carbon dioxide, forests help in maintaining hydrological cycle, regulating the climate, protecting the soil from erosion, and also promoting soil formation. In addition, forests are important sources for various types of food and fuel, particularly for the developing nations. Forests contribute most towards the development of many species than any other ecosystem. Because of rapid deforestation all over the world, particularly in developing countries, human beings are gradually and continuously being debarred from all these benefits.

The destruction of the forests in the Himalayan region, the world's greatest mountain chain, has affected mostly to the people of India, Bangladesh and Nepal. Over the last 40 years, nearly 40 percent of this forest in the Himalayan region has been cut down. Since the conquest of the Everest in 1953, mountains of Nepal have lost at least 50 per cent of their trees. Nearly 35 to 75 tons of top soils are being stripped from each hectare of its barren slopes every year. In recent years, the conditions have deteriorated so much that, the people in the higher regions keep watch day and night during the monsoon for the landslides. In many villages of this country, nearly three quarter of the farmers have lost some parts of their land in this process. With the depletion of the fertile soil, the quantity of harvest has also dropped considerably.

The Ganga and Brahmaputra, the two biggest rivers of India, have originated from the Himalayas. These two rivers are carrying more than three billion tones of soil every year from their courses in the bare region to the Bay of Bengal, spreading over three million square kilometers of the seabed. Much of the sediments do not reach the sea but coats the riverbeds, raising those by more than 15 cm. every year. As a result, the rainwater rushes more rapidly in the shallow river, causing in frequent floods in various near by areas. In the past, when the Himalayas were covered with trees and bushes, the former Eastern India, presently the Bangladesh, used to suffer from heavy floods every 50 years. Due to cutting of trees in large scale in the Himalayan regions, by 1970 the heavy floods were occurring once in every four years and presently it happens every year. Due to rapid deforestation, India's flood prone areas increased from 55.6 million acres in the year 1969 to 130 million acres in the year 1980. Meanwhile, due to deforestation and shallower river beds, the regular water supplies are diminishing very fast. According to the forest resources assessment project of FAO, during 1980 to 1990, the total surface area covered by the tropical forests in the world decreased from, 19.35 to 18.82 million square kilometers. The annual deforestation rate increased from 0.6 percent in 1980 to 0.9 percent in 1990. For the very survival of the human beings on this planet, the existing forests have to be saved and new forests have to be created.

Environment:

Our Mother Earth which till recent past, was a green, healthy, and beautiful place to live in for all the living beings, is getting devastated very fast because of harsh exploitation of its resources in a haphazard and unsystematic manner. Rapid industrialization and urbanization have no doubt brought a lot of material developments but in return caused much more devastation in different parts of the earth and also very much responsible for disturbing the equilibrium of the nature. In the process of rapid industrialization and urbanization, large chunks of green forests and vegetation are being cut. The earth surface is also being distorted and damaged immensely. The air and water bodies are being loaded with poisonous gases and other harmful substances released from industries, transport systems and other human activities. In this way, the land, water and air bodies of our planet are getting polluted very fast. The pollution level of earth during last century has far exceeded the cumulative effect which occurred during the rest period since human existence on this planet.

One of the major problems in this regard, is the "Greenhouse Effect". The creation of "Greenhouse effect" on the earth's surface is due to the release of heavy amounts of carbon dioxide, methane, water vapour, oxides of nitrogen and sulphur. As a result of this, we have started experiencing a great deal of unfavorable climatic change, appearance of various types of fatal diseases, frequent floods and droughts, rise of sea level causing immersion of small islands and many low-lying areas, melting of glaciers

and many more disastrous consequences. As a result of environmental pollution, both the surface and ground water bodies are getting heavily polluted making it unsuitable for drinking and other domestic purposes. Heavy industrialization and network of transport systems are mainly responsible for releasing a lot of solid wastes, liquid and gaseous effluents to the soil, water and air bodies and making the human beings, animals and plant life most miserable.

Is this what we call Civilization? Are we using science and technology in a proper way? Once the fertile Ethiopia is now a drought prone hungry nation, the Amazon River in South America bearing 20% fresh water of the planet, is completely polluted with mining and other industrial activities; the vast tropical forest on earth's crust has become a sight of the past. In spite of all the advancements made in science and technology, because of our irresponsible and careless activities; the human race along with plant and animal kingdom is heading towards a non-reversible disastrous situation finally leading to extinction.

Scientists believe that, what ever bad effects due to the global warming, are being experienced at present, are those from the green house gases released thirty to forty years back. From this, one can imagine what would be the situation fifty years hence.

Possible Remedies:

Human beings have moral responsibility to mend these man made destructions with immediate effect particularly for their own benefits and survival. In this regard, the modern science and technology have got a great role to play. In recent decades, a lot of efforts are being made towards conservation of the vital resources like minerals, water, forest and soil and to properly develop these along with maintaining a pollution free environment. In the following pages some positive steps being taken and to be taken have been highlighted.

(1)Mining of ores and minerals and their utilization in metallurgical and allied industries can be most effective and useful to human society, provided the lean and complex minerals as well as the waste materials of the concerned industries are properly managed, energy required is economized and environment is suitably protected. In recent years, both in developed and developing world, due to enforcement of stringent environmental rules and regulations for betterment of human beings, these industries should develop and apply Environment Friendly Best Available Technology (EFBAT). The objectives should be:

(a) to maximize the production with minimum consumption of minerals and energy,

(b) to generate least amount of solid wastes and effluents,

(c) to conserve the resources and recover values and toxic materials from the wastes before releasing to the environment and

(d) above all taking maximum care to keep air, water and soil free from the pollutants.

The major industrial wastes like slags, red mud, fly ash and slimes and tailings pose environmental problems globally. As a result of intense R & D efforts, Blast furnace slag, which was a problem a few decades back, has already proved itself as a resource in most part of the world. In thermal power plants, as mentioned, colossal amounts of fly ash are generated as waste.

As fly ash is a nuisance to the environment and its production being colossal in amount, all out efforts should be made for its complete utilization. In many developed countries, nearly 90 to 100% of the fly ash produced, is utilized at present for various purposes. Some of the major potential uses of fly ash are given in **Table – III**. It is suggested that, serious efforts should be made to utilize most of the fly ash in filling of the mined and low lying areas.

Table –III
Possible uses of Fly Ash

(a) Mine fills and development of low-lying areas.
(b) Manufacture of building material products like bricks, slabs and blocks.
(c) Fly ash based concrete and road construction materials.
(d) Light weight aggregate.
(e) Soil Stabilization.
(f) Structural fill.
(g) Distemper and Paint.
(h) Raising of ash dykes.
(i) Blended cements like masonry cements or lime pozzolana cement.
(j) Metal Recovery (Aluminium and Iron). Manufacture of Mineral wool & ceramics

The major byproduct of alkali digestion of Bauxite to produce alumina, is the red mud. The generation of red mud is 1.2 to 1.5 ton per ton of hydrated alumina produced. The red mud contains mostly the oxides of iron, silica, and some alumina with other trace metals along with the most objectionable residual sodium hydroxide, making the disposal of such a highly alkaline sludge (pH = 11 to 13), a most problematic issue. This red mud contains around 3 to 5% by wt. of caustic which renders it poisonous for water bodies as well as agricultural and grazing land. To neutralize and also to reduce the caustic content of red mud, considerable amount of research are being done. For example, the waste heat of the steam from thermal power plant to recover the caustic value, has been tried with partial success to reduce the pH of the red mud slurry from about 14 to 10.5.

In India, nearly two million tons of red mud is being generated in various alumina plants per year at present. In recent years, more emphasis is being given for safe disposal of red mud, but unless suitable avenues are developed for utilizing these wastes as resource in large quantity, it would continue to be a major environmental nuisance.

The possible utilization of red mud is given in Table - IV.

Table – IV

Possible uses of Red Mud

a. Cement making (alumina ferrite cement): - Cement with some amount of red mud has been found to have higher strength due to formation of di-calcium silicate phase in clinker.

b. Mixture of Red mud and fly ash along with some cement for making building bricks.

c. Red mud mixed with rice husk and clay for producing building blocks. (Red mud : rice husk : clay 1:2:1).

d. Producing Composites using natural jute fiber as reinforcement with red mud as filler material.

e. Preparation of red oxide pigment.

f. Extraction of iron value from red mud and

g. Conversion of red mud to ferroalloys after suitable treatment.

In recent years, the tailings and slimes of the beneficiation and washery plants of mineral industries which are also huge in quantities and detrimental to the environment are being processed to recover the values. However, much more has to be done in this regard and the final residues should be utilized for land filling and road constructions with or without pre treatment. However, the mining and mineral based industries should adopt best available environment friendly technology to produce minimum wastes and should aim at releasing zero waste to the environment. Further, these industries should take necessary steps to recycle and process the wastes to recover the values and toxic materials before releasing those to the environment.

(2)At present, world is passing through an acute water stress period. Further, due to various uncontrolled human activities, most of the rivers and lakes have been polluted extensively as well as the ground water resources at a large number of places. By consuming polluted water, a large number of our population particularly the children are being affected by various water borne diseases and many of them are dying prematurely.

It may be mentioned here that, irrigation consumes nearly 70 pct. of water resources. In many countries it is mostly extracted from the ground water resource resulting in rapid decrease of water level in the aquifers. This has posed a very serious problem for the country. Specially in the arid and semi arid regions where water scarcity is acute, the ground water mostly meets the irrigation as well as the domestic demand. In such areas, to meet the demands for both the sectors, intensive rain water harvesting particularly artificial recharging of aquifers, has to be adopted in a systematic and massive way.

It has been estimated that, in the world with increase in population, food grain production by the year 2050, is likely to be doubled. Similarly, the domestic as well as industrial water requirements are expected to be doubled or tippled. In view of this, serious efforts are to be made to have an integrated fresh water management programme. Some of the important factors responsible for polluting the surface as well as the ground water are poor land use practices and direct pollutant discharges to the surface water bodies as well as to the ground. Further, inefficient water management is reflected in poor patterns of water delivery and water losses through seepage, leaks and evaporations. For examples, in India, nearly 47% of the water being supplied, is lost in the distribution system before it reaches the consumers. These practices should be changed and modern technology should be utilized to conserve and judiciously utilize the water resources.

The spongy characteristics of landscape when altered, would result in diminishing water absorption making the land to capture less rain fall than before. This results in more water run off on the land and transfer of much less amount of water through the soil into the aquifers. At present, most of the landscape is drastically altered due to removal of vegetations and landscape drainages by ditches and canals. As a result, wet soil turns to dry soil, reducing the ability of the landscape to retain water. Further, the construction of dams leads to serious alternations, in hydrological patterns and also reduces the water availability to communities down streams. Elimination of flood pulses and decrease in inundation of down stream flood plains result in drastic reduction in the amount of aquifer recharge. Thus, hydrological alteration of the land scale along with dam construction very often lead to water quality degradation and rendering the water unsuitable for domestic purposes . It is therefore essential to protect the land scape, undertake massive plantation around the water bodies and avoid construction of large dams.

Some of the remedies towards integrated development and conservation of our fresh water resources, are summarized in Table - V.

Table – V
Measures for Conservation and Management of Fresh Water Resources

(a)	Rain water harvesting on surface as well as charging to aquifers should be carried out in a scientific manner without any contamination.
(b)	Adoption of efficient irrigation system like sprinkle and drip irrigation and encouraging farmers for producing crops, which consume less water
(c)	Loss in water transport to be minimized by adopting improved technology.
(d)	Treatment of sewage, industrial effluents etc. before discharging the treated water to the main water bodies, has to be practiced.
(e)	Programmes for development of wet lands and creation of new water reserves to harvest more rain water and recharging aquifers and developing aquatic wealth have to be undertaken.
(f)	Industries should have captive rain water harvesting programmes to meet their water requirements and also should recycle the waste water.
(g)	Measures to minimize the use of chemical fertilizers and pesticides in agricultural fields, instead using organic manures and organic pesticides have to be popularized.
(h)	Pricing of water has to be done in a rational manner.
(i)	Arrangements have to be made to provide portable water to all and
(j)	Regular monitoring of water quality (both surface and ground) needs to be carried out both in rural and urban areas.

The government at different levels should gear up it machinery to implement the above prorgammes using modern technology so that the people in their respective country while getting enough portable water should lead a healthy life while achieving sustainable socio economic developments both in agricultural and industrial sectors.

The first major UN conference on water held in Mar del Plata in 1977 stated that "all peoples, what ever their stage of social development and their social and economic conditions, have the right to have access to drinking water in quantities and of a quality equal to their basic needs".

(3)All countries in the world particularly the developing ones should make serious efforts to bring most of their barren and waste lands under afforestation programmes along with adopting intense social forestry programmes. These countries should follow the example of Japan, Germany and also many other European countries. According to the FAO, the annual growth rates of the forest areas in most of the European countries have been increasing. The forest stocks grew by an average of about 12 percent between 1960 to 1970 and the annual growth rate is about 9 percent at present. Though Japan is a small country consisting of hundreds of islands and is densely populated, yet due to sincere and continuing efforts of both the government and private organistions, today about two third of this country is covered with forests.

Nearly thirty percent of the land in India, are barren or considered as wasteland. These include the sandy coastal region, the mine areas which have been made barren due to extensive mining, the swampy low lying areas with water logging, the unproductive soil eroded barren lands and also the unused lands on both sides of the motor and rail roads. Different scientific and social approaches have to be made to plant trees in each type of these wastelands and convert these into man made forests. The scientific approach and phased programmes of plantation in the seacoast or the swampy low lying areas or the sandy deserts are going to be very different. Therefore, these have to be planned properly and executed timely and appropriately. Further, plantation in the wastelands near habitation has to be done in a more realistic manner.

Most of the rural population depend very much on trees for getting fuel for cooking their food and fodder for the animals. So, in such areas, fast growing species as well as oil and fodder producing trees should be planted. Barren and wastelands should be given to the nearby villagers to plant and manage the forest in a cooperative manner. This is one of the most effective ways to protect the forest.

(4) Various human activities are not only wasting the essential natural resources but also rapidly polluting the environment. In recent years, we have been experiencing a serious change in weather indicating the early appearance of the disasters.

Before it is too late, mankind should realize the seriosity of the situation and take the responsibility to save the living creatures on this earth. The effect of global warming cannot be confined to any particular region. Every nation, every human being, every animal and plant are going to suffer and perish if nothing substantial is done from now onwards to minimize the global warming and the pollution in general.

The energy producing units and the engines of various transport systems should be based on environmentally friendly technology. Efforts should be made to produce more and more energy from pollution free fuels for different purposes, so that least amount of carbon dioxide is released to the atmosphere from these.

While debarring to cut the forests, there should be mass movement for creating new forests in wastelands, sea shores and also around human settlements. Trees play a vital role as the sink for carbon dioxide. Use of wooden furniture and wood for building houses should be drastically restricted. Shift cultivation in forest areas and mines should be stopped immediately. To allow more land for plantation human settlements should grow vertically instead of horizontal expansion as much as possible. In domestic cooking and heating wood and wood charcoal should be avoided.

Out of all the conventional energy sources, hydro power is the cheapest and environmentally clean. However, even with full utilization of hydro power, only 30% of world's present requirements of energy can be met. In order to harness more energy from hydro power technology should be developed to produce hydro power from small streams, rivers and water reservoirs without building any big dams. During recent decades, various efforts are being made to harness energy from non conventional sources like sun, wind and geo thermal energy. Geo thermal energy is the one which is extracted from the heat content in the dipper region of the earth. The solar and wind energy are unlimited and can be considered as renewable and non exhaustible energy sources. With the advent of various technological developments, it has been possible to apply solar energy for cooking food in a solar cooker, heating water by solar heat collector and with the help of photo voltaic cell to produce electricity for running small mills, lifting water for irrigation and many other technical purposes. Developing countries in the tropical region like India with abundant sunshine during most part of the year should make best use of modern technology for harnessing the solar energy at least for cooking, lighting houses and streets, pumping water for irrigation and feeding power to small scale industries.

In order to conserve and judiciously utilize the natural resources, the policy makers, planners and plan executers of the respective country are to put their serious efforts. In different areas, they should utilize the best available environment friendly technology. However, for minimizing the green house effect, the developed nations have the major role to play. Nearly 85 percent of the carbon dioxide and CFCs, which are mostly responsible for green house effect, are being released from various sources by these countries. Developed countries should come forward to help in providing clean technology free of cost to developing countries and this will create an congenial atmosphere of 'live and let live'. It is high time for all human beings to change the living style from the present one to a sustainable living in harmony with the nature.

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National Institute of Science Education and Research (NISER): It's Vision and Mission

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I. Introduction

On 28th August 2006, the Prime Minister of India Dr. Manmohan Singh announced for the establishment of the National Institute of Science Education and Research (NISER) at Bhubaneswar, which will be operated under the umbrella of Department of Atomic Energy (DAE) of Govt. of India. He announced that the NISER will facilitate the synergy between research and higher education in science. He had stated categorically that NISER will be compared with the best institutions in the country in terms of facilities and faculty. The Atomic Energy Commission, in its 182nd meeting held on 16.03.2007 approved the proposal for establishment of NISER at Bhubaneswar. Till the permanent campus comes up, NISER will be functioning from the beautiful campus of the Institute of Physics (IOP), Bhubaneswar, a renowned Institute with state-of-art infrastructure that includes an excellent library, a large computer centre and a number of outstanding research laboratories. The government of Orissa agreed to give 300 acres of land to build the campus of NISER at Jatni in Khordha district, near the Barunei hills and about 20kms from Bhubaneswar railway station.

The Union Cabinet on 6th September 2007 gave its approval for establishment of National Institute of Science Education and Research (NISER) at Bhubaneswar at an estimated cost of Rs. 823.19 crore and also creation of 761 posts in academic, scientific, technical, administrative and auxiliary categories for seven year plan. The first academic program of NISER was inaugurated by the Chief Minister of Orissa - Sri Naveen Pattnaik on 10th September 2007 at the IOP campus. 40 students were enrolled for the inaugural batch of the integrated 5 year M.Sc. programme through the entrance test NEST. Prof. T. K. Chandrashekar joined as the first Director of NISER on Dec 8, 2008 and Dr. A.K Naik, as first Registrar in February 19, 2009. Currently, NISER is utilizing the facilities of IOP for functioning. A beautiful building has come up inside the IOP campus which has space for administration, classes, laboratories, computer centre and a large Lecture Hall.

Vision:

National Institute of Science Education and Research (NISER) is envisioned to be a unique institution of its kind in India. NISER will strive to be recognized as a Centre of Excellence in science education and research in four basic sciences (Biology, Chemistry, Mathematics and Physics) and in related areas. The aim of this special institute is to nurture world class scientists for the country who will take up challenging research and teaching assignments in universities, R & D laboratories and various industries. The exemplary teaching and research attributes of its faculty will inspire strongly motivated bright young students to dedicate their lives for scientific research.

In the beginning NISER will seek affiliation with Homi Bhabha National Institute (HBNI), a deemed University within the Department of Atomic Energy, for the award of degrees. At a later stage it will seek UGC approval to get the status of a deemed university for awarding degrees on its own.

The academic programme will be designed to provide strong foundations to students, through core courses, before they embark at the threshold of research in the field of their choice. However, NISER's curriculum will ensure that every student is introduced to excitements in the frontiers of knowledge in other branches of fundamental sciences. Therefore, NISER will create an environment of scientific culture where every member will excel in any field he desires to pursue. Although there will be four main schools, disciplines like computer science, engineering sciences and earth and planetary sciences will also be included at appropriate stages.

NISER recognizes that modern scientific research is carried out in a domain without any boundaries. The undergraduate students and research scholars will flourish in the ambiance of this scientific culture. In this perspective, it is expected that faculty members from different schools would try to establish centers of research in inter-disciplinary areas while discharging their teaching duties of core courses of the respective schools.

It is envisioned that a faculty member will devote 30 to 40 percent of his/her annual time for teaching and will devote the rest to research and guiding research scholars. The faculty will be given generous research grants to pursue cutting edge research in frontier areas. Thus the process of

education shall be carried out in a thriving research ambience. Small student-to-faculty ratio will be a hallmark of NISER's education programme. The teaching and research programs of NISER will be reviewed from time to time in order to evaluate its achievements and to receive constructive suggestions to know how it is fulfilling its mandates. It is natural that NISER must be very careful in the selection of students and in the appointment of its faculty.

NISER will insist on student evaluation of each course and capabilities of its instructor at the end of each semester after the grades have been submitted to the concerned authorities by the instructor. This will serve as a self-correcting prescription towards improving both the syllabi and the teaching abilities of the course instructor.

NISER will demand dedication and commitment from its students. They must be responsible for their performance and utilize their time at NISER. Their primary aim is to build themselves to take up challenging research and teaching assignments in universities, R&D laboratories and various industries. They should be aware that their talent is recognized and totally supported by the society with resources. Therefore, they must develop a sense of indebtedness to the society at large. NISER will consciously endeavour to create an atmosphere of fraternity, cooperation and a sense of social responsibility.

The academic curriculum, including the structure of courses, laboratory hours, emphasis to study interdisciplinary subjects etc. will be framed with a vision that NISER will provide strong foundations in subjects of specialization with a broad perspective in fundamental sciences. The courses will be designed on a credit-system and emphasis will be on earning the credit rather than only attending lectures. The regular class room teaching will also be augmented by WEB-based courses so that the talented students can earn extra credits through these courses. This will also reduce the teaching load on the faculty.

The facilities like a modern library with books, journals, vast reading areas and electronic means to access various sources, computer centre with wireless network all over the campus, modern laboratories to acquire skills to perform experiments, to innovate, to fabricate and to conceive new experimental techniques etc. are proposed with those themes. The students will learn through their course works, through seminars, through mutual discussions and by informal interactions with faculty members. In other words, NISER will represent an integrated system to acquire knowledge and explore the unchartered frontiers.

NISER will utilize its privileged position to foster, nurture and encourage teaching and research in all academic institutions. It will have an in built cell for organizing seminars, workshops, symposia and conferences to enable wide interaction among the students and academician. It will also award associateship to deserving researchers in colleges and universities to permit them to spend time at NISER and pursue their research.

II.Institute Profile

Present Transit Campus

NISER is presently located in the Institute of Physics (IOP) Campus, near Sainik School, Bhubaneswar, Orissa - 751 005, INDIA. IOP has a campus spreading across 75 acres, which houses a state of the art Library, large Computer Center, Ion Beam Laboratory, Nanostructure Laboratory, besides the Main Academic building and a newly constructed centrally air conditioned extension building, which is partly used for Classrooms and Faculty rooms for NISER, canteen, and playgrounds. The entire campus is filled with lush green trees and a beautiful garden lays in front of the main building.

A beautiful building for NISER has been constructed within IOP campus. The Laboratory blocks for Biology, Physics and Chemistry, class rooms, library, computer centre, faculty rooms and administrative offices is now operating from that building. The hostels and faculty quarters are located in Blocks C 1, D - 4 & D - 5 in the New Government Colony adjacent to Sainik School.

Permanent Campus

NISER's permanent campus will be located at Jatni in the Khurda District, about 4kms from the Khurdaroad railway station which is about 20kms south of Bhubaneswar Railway Station and about 25kms from the existing Bhubaneshwar airport. It is about 2-3kms away from the proposed site for IIT, Bhubaneshwar. 298 acres of land have been handed over by the Government of Orissa for this purpose.

Library

The NISER library (circulation section) is located within the new academic building of the institute and it's reference section is adjacent to IOP library. Library is growing rapidly and is expected to expand into an outstanding library within the next few years. The members of NISER can also use the books, journals and other facilities of IOP's excellent library.

1. ***Books:*** Currently, NISER library houses around 9000 books in the disciplines of Biology, Chemistry, Mathematics, Physics, Computer Science and other interdisciplinary areas.
2. ***Journals***: Currently, NISER library houses around 1500 journals in the disciplines of Biology, Chemistry, Mathematics, and Physics mostly in electronic version.

NISER has online access to the Science Direct as being a DAE institution.

Schools

NISER has both teaching and research labs of each of the schools (Biology, Chemistry, Mathematics and Physics) and they are growing rapidly. NISER also uses the lab facilities of IOP.

School of Biological Sciences

The School of Biological Sciences aims to establish itself as a leading international centre for research and teaching with harmonious synthesis of classical and modern biology - always promoting scholarship, original thinking, innovative ideas and cutting edge research. The following missions has been taken for laboratories of School of Biological Sciences.

- To strive to become a centre of excellence in education and research in biological sciences providing training at undergraduate, graduate, doctoral and post-doctoral level.
- To provide effective interdisciplinary learning ambience through extensive subject coverage in all fields of modern biology and inter-phasing with other scientific disciplines.
- To equip its students to keep pace with recent developments in the field of scientific research.
- To undertake high quality research activities in defined areas of biosciences so as to make an impact at national and international level.
- To impart professional training for skilled human resource development across the state and country through short term training courses.
- To strive to develop state of the art infrastructure comparable to best anywhere in the world.

School of Chemical Sciences

Chemistry as a subject has considerable impact on our everyday lives and on other scientific disciplines. The aim of the School of Chemical Sciences at NISER, is to impart high quality undergraduate and postgraduate level of knowledge to students coupled with cutting edge research activity by the faculty and the students of the school. In addition to traditional organic, inorganic, physical and theoretical chemistry areas, the school embarks on teaching and research activity in the interface areas of Biology, Material Sciences and Medicine. The teaching philosophy at NISER is not only to impart high quality training to students to make them talented and motivated scientific personnel but also to inculcate human values and concern for societal needs and environment. The School of Chemistry offers one of the best integrated M. Sc. programme and the syllabus is designed not only to teach basic principles but also to have hands on practical experience by doing research projects as a part of the curriculum. The School of Chemical Sciences will also start Ph.D programme soon to take up research problems in frontier areas of Chemical Sciences.

School of Mathematical Sciences

Mathematics occupies a core intellectual position at NISER, an institution that is striving to be recognized as a Center of Excellence in science education and research in basic sciences. The School of Mathematics was established as a core department of the NISER along with other three Schools from the very beginning of NISER in 2007. It is growing rapidly and is now functioning in full swing. The school currently, offers master's programme, M.Sc. (5yr integrated) in Mathematics. The PhD programs will be introduced very soon. The school aims to train people who are oriented towards research and teaching in both basic and advanced areas of Mathematical sciences. Moreover, as all basic sciences need mathematics, we enjoy a special responsibility to teach all these motivated bright students to appreciate the subject the way we do. The School of Mathematics aims to have a vibrant academic and research ambience for faculties, students and visitors. To fulfill the vision of the NISER and it's School of Mathematics, we look forward to recruit people having very good research contributions in Mathematical sciences and high motivation for teaching.

School of Phyusical Sciences

The school of Physical Sciences is a growing department, with strong programs in academics and research. Physics is the study of the structure of the material universe, the particles that comprise it, and the forces by means of which these particles interact. We strive to engender in students an understanding of that structure and those particles and forces, and an appreciation of these fundamental principles.

Computational Laboratory

1. ***Computers***: NISER provides state of the art desktop computers to its faculty and staff. The computers in computer labs and computer center are used by students and visitors. Each computer of NISER is connected by a very fast and well-connected local area network (LAN) and internet access is available.
2. ***Computer Center:*** The computer centre of NISER mantains proxy, mail, DNS, web, library servers and provides computating facilities to members of NISER through LAN. The back bone is a server class computer

running on a Linux operating system.

3. ***Computing Laboratory:*** The NISER has a computing laboratory for teaching as well as research. All computers in the laboratory run on GNU/Linux operating system and are connected to NISER servers. A large number of open source and proprietary computing softwares like SCILAB, SAGE, MATHEMATICA, MAXIMA, LaTeX, gnuplot etc are available to users. NISER is planning to build a computer lab of high speed computers for research, a bio-informatics laboratory etc. The NISER has also procured a High Performance Computing cluster having throughput of over Terraflops.

4. ***Network:*** All the computers at NISER are connected by both wired and wireless high speed networks. All computers access 12 Mbps (Firewalled) internet connectivity. All the individual laptops can access Wi-Fi facility to access internet and LAN. NISER's LAN is also connected with the LAN of Institute of Physics and the users have access to all the facilities of both the LANs.

III Course Offered

NISER offers the following courses:

1. An integrated 5 year M.Sc. programme in the core and emerging branches of Basic Sciences to students after their 10+2 Higher Secondary schooling. Minimum percentage of mark in 10+2 is 60%. Candidate has to write an entrance test called National Entrance Screening Test (NEST).
2. An integrated M.Sc.+ Ph.D after B.Sc degree (course yet to be started)
3. Ph.D. programme after M.Sc. degree. Eligibility for taking admission in Ph.D. programme is one should clear NET/GATE/UGC/JEST etc.

NISER is functioning from the campus of Institute of Physics, Bhubaneswar in its initial years and it will shift to its sprawling campus at Jatni located at the outskirt of Bhubaneswar in a few years. Institute of Physics is a renowned institution situated in the central part of Bhubaneswar. There are several academic and research institutions in the proximity such as Utkal University, the Institute of Minerals and Materials Technology (formerly RRL), Institute of Life Science and Regional Medical Research Centre (of ICMR) to name a few. Institute of Physics possesses very good infrastructure such as an excellent library, computer centre and several research laboratories.

IV. Future Expansion

When NISER will operate from its own campus at Jatni the following new courses and new branches will be added to its academic profile:

1. Three new branches will be added. These are: a) Earth and Planetary Sciences, b) Environmental Sciences, c) Computer Sciences
2. M.Sc.- 2 year couses will be introduced in each branch of Basic Sciences.
3. Intake of Integrated M.Sc. will be 200 per year
4. Intake of Ph.D. students will be about 100 per year

V. Placement Scenario

The aim of this special institute is to nurture world class scientists for the country who will take up challenging research and teaching assignments in universities, R & D laboratories and various industries. The exemplary teaching and research attributes of its faculty will inspire strongly motivated bright young students to dedicate their lives for scientific research in India and abroad.

Preference will be given to NISER students in all units of DAE like BARC Mumbai, TIFR Mumbai, IGCAR, Kalpakam, NFC, Hyderabad, VECC, Kolkata etc.

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About Popularization of Science In Some Arab Countries

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1- Introduction

I would like to begin this contribution by thanking the Government of India (Ministry of Science and Technology) and the UNESCO for inviting me as a speaker, and especially to talk about an issue to which I feel very concerned which is the Arab States experience on Popularization of Science. Since this is a Region which is beginning to be perceived differently, I have to make a preliminary observation on the origin of this change in perception of the Arab world. It has been just one year since the ignition of the Tunisian revolution. Since then it has spread to many other Arab countries. It is the "*Arab Spring*", using the expression now in vogue. It is a "good season" that continues to raise the enthusiasm and create hope. Unfortunately I cannot say the same thing in regard to the state of science neither in regard to the critical thinking. In fact, we are unable to speak of the "Spring of Sciences". It passes the low point and we rather call it the "low season". It is also the object of my inquest which I propose to share with you this morning.

To discuss this significant matter, I will rely on my own experience as "Head Chief" of one of the most important scientific culture project in the Mediterranean which is the "City of Sciences of Tunis" and as a chairman of *forum Science and Society* in Tunisia. I will also sustain this contribution with my experience as a consultant in management of science projects, particularly in the Arabic world.

2- Science is universal, then its practice is cultural: true for yesterday is still true today?

Before going into our main topic, I would like to put across a comment that I was inspired in the course of the Network of Popularization of Science and Technology throughout the World and above all through their divisions: the ECSITE in Europe, the ASPAC for Asia-Pacific, the RED-POP for Latin America and the Caribbean,...

Beyond its practical preoccupations as, for example, the co-production and the co-organization of itinerant expositions, it is a conglomerate which is concerned by the task to diffuse the following idea: if science is universal, then its practice is cultural, therefore it is specific. The idea is largely acknowledged and commonly admitted, but it seems to me that it is already long-lived. In fact, this assertion is first of all not entirely exact and secondly it is a confirmation of cultural specificity which has its own flipside and consequently may be conducted contrary to what is expected of education by Science.

2-1- Hand's on: beyond design, is there a difference between an Exploratorium and another?

I fact the affirmation is not entirely exact because science is the most universal human activity and also its practice (at least some of its practice) tend to be generalized and widespread. Indeed, we disclose the same physics from Tunis to Canberra passing by Dubai and Calcutta City Science and we tend more and more to use the same exhibit to put in evidence the principles of this same physics. It is sufficient to be convinced that observing how the big "Exploratorium", especially that of San Francisco, was, on a smaller scale, worldwide reproduced to the same image: from "hand's on" of Copenhagen to the exploradrom of the Parisian suburbs and from Cardiff to Kuwait City. Obviously, minor modifications were brought up to give a local touch.

It is so much the better that in a globalized world, where we find it hard to understand each other on the least of "the living together", we are able to offer to our children the same exhibits to share.

However, the popularization of science is not simply a question of a playful experience to occupy and distract kids and their parents with, but most importantly an education in the citizenship. Don't we say that science education helps to put things in perspective, aid to better position our self in forging our own image benchmarks. In brief to see the world as it is and not what we would like it to be.

2-2- In the Arabic World: the cultural practice of science commonly confined to the evocation of religion in science! Is the concordism the rule?

This leads me to the second part of my remark and possible flipsides that can be conceded with the cultural specificity affirmation throughout this "popularization of sciences". In fact, the museography of some science Arabic

centres is very symptomatic of this drift as it is not rare. For example, in order to demonstrate the water cycle, which should start with the hydrologic balance, instead it begins with the famous Verse 30 of the chapter 21 of the prophets (Koran) "We have made of water everything living, will they not then believe". I may say here that if everything is said and announced in advance, why do we further look or search?

This "concordism" which doesn't say openly its name becomes an infringement to the scientific mind and even to the aims of the "popularization of science" when it is set up today as "sciences centres". It is the case of the "creation museum of Petersburg" in the Kentucky where, thanks to a great direction worth of Disney World, visitors are shown Adam and Eve living with the Dinosaurs. Also another example is the creation museum of "Harun Yahya group" where the scenery of creation denies, on the basis of Koran, the evolution theory. The problem could have been of no great importance if this amalgam hasn't been brought up to schools.

This preliminary observation has been put forward at the opening of this presentation to emphasize two facts, which to me, deserve to be discussed.

First of all, we face practically the same challenges in the dissemination of science, in other words we have more things that bring us together than things that divide us.

Then, the "popularization of Sciences" is not limited to "Science Centres" and their Hard's on. It is also a culture and as such, it educates for citizenship, so it is far from being a luxury and all of us, young and old including scientists of fame are in continuous need of this.

The latest statements by James Watson show that even a Nobel Prize winner may advocate a dialogue which goes against all logic. In other words, the scientific culture must, in my opinion, denounce and go against everything that distorts and alters the human species.

Then I will begin my exposé by the challenges facing us in the popularization of science, "then I will address some aspects that characterize the Arab area, I will end my speech with a conclusion, not on the management of science cities or science centres, but on the attention that should be accorded to the development of scientific culture in universities in particular, and this may appear paradoxical, towards science students. Some forms of dogmatism thrive when science is disclosed without its history and culture.

3- The scientific culture: Stakes and Challenges

3-1 Science today

To be gratified or to be worried about, science is, more than ever, changing the way we live, think and act. Its performance will lead humanity beyond what it can imagine. The reality is almost fiction and the genetically modified human being is no longer a simple isolated researcher. The stakes are multiple. They are at the same time: citizenship, social and scientific. With regard to citizenship, as everyone notes in their daily lives, the world has become a truly global village where humanity is now an all, but an "all" which is not united. In this new context where social link, spiritual values and esthetical forms experience incessant turmoil, the individual is caught between regret of the past and the fear of an uncertain future. Disoriented, he is searching for meanings and benchmarks. Religion stays the last refuge. Because science is objective, its contribution into culture could help us better understand the world in which we live and progress. So a "minimum wage" of scientific culture guaranteed for all citizens, would help to overpass the gap between reality and representation created by governments and citizens. With regard to the social issue, the alliance of science and technology has helped unprecedented productivity gains to the point to distress all modes of production and with them all our ways and styles of life. We have quickly passed, at least in the industrialized countries, from an opulence society where the issue was the distribution of wealth to what others call the risk society or the end of utopia zero risk.

So today, scientific culture will explore not only the functioning of these technical innovations, but also will stop at the creative thinking that has led to these innovations and at the multiple relations between science and societies.

The third issue concerns the science itself, i.e. science as production and workplace. As far as scientists are concerned, driven by the fever of publications, career oblige, they are rarely interested to the periphery of their knowledge which induces a virtual absence of reflections on science in places where science is undertaken. To overcome this, the development of scientific culture among scientists is the necessary complement in the formation of citizen researcher.

It is culture and culture alone which allows today this essential combination between conscience and competence.

3-2 The syndrome of James Watson: science without conscience is the wreck of the soul

Without this combination, a threshold soon arrived. Indeed, it is unfortunate for the human kind, that, in the last few years (2007), a worldwide recognized competence as James Watson, Medicine Nobel Prize Winner, displays his recklessness, when he said: "I am inherently gloomy about the prospect of Africa because all our social policies are based on the fact that their intelligence is the same as ours, whereas all the testing says not really". The Nobel Prize winner also said: "there are many people of colour who are very talented but don't promote them when they haven't succeeded at the lower level.

Fortunately that alone, Dr. Watson doesn't represent science. Scientific voices proclaimed an adjustment and denounced his misleading views such a Dr Elies Zerhouni, director of he National institutes of Health who said "Scientific prestige is never a substitute for knowledge. As scientists, we are outraged and saddened when science is used to perpetuate prejudice".

As for scientific production, it lives in the beginning of this new century a major and important turning point: the idea that science is first and foremost a production of new knowledge is now outdated. Today, the stakes are less in the production of new knowledge and in its ability to collect and its distribution. In other words, the appropriation of science would be random if we do not prepare the appropriate background. As such, there is more than one lesson to be learned from the saga of science in its first golden age with the Islamic Arab civilization. Science wouldn't have known such an expansion if cultural centres did not flourish from Baghdad to Damascus, Fes to Kairouan, and from Granada to Cordoba and Toledo. This period is invoked only as a reminder that modern science is a collective enterprise, led in turn by various peoples. Consequently, there is no reason to believe that some people would be more willing than others to take science. Only their commitment to science makes the difference! It is in this perspective that the history of science is introduced and developed in some "Arab Science Centers" in particular in Tunis Science City.

4- Case of Arab World: Would it be struck by a scientific curse?

4-1- If Nobel prizes have existed thousand years ago, Arab World would have earned many of them in the scientific field

The question arises as there was a time when the Arab world, nowadays in an unpleasant scientific position, was the Mecca of science during an entire six centuries from the eighth to the thirteenth: Sorry for the short time!

In fact, we owe to the Arab World three of the finest achievements that the human mind has invented: the observatory, the hospital and the university.

4-1-1- the observatory

As far as observatories are concerned, although many astronomical instruments have been invented by the Greeks, it is under the auspices of Abbassid caliph Al Maamun that was created the first permanent observatory. It was in Baghdad in the year 830.

4-1-2- the hospital

The Arabs have greatly contributed to the development of medicine and the organization of hospitals. The school of Medecine of Kairouan, created by Ishaq Ibn Umran and developed later by Ahmed Ibn Al Jazzar at the beginning of the XI century, is one of these contributions of which ideas can still be seen in hospitals today.

4-1-3- the University

As for the creation of universities, more and more evidences are suggesting that we need to seek the origin of the university at the beginning of the golden age of Arab science. The college Mosque al Quarawiyyin of Fes in Morocco was founded in 859, Beït al Hekma in Baghdad funded by El Mamun 813-833, the college mosque of El Azhar in 972.

Furthermore, we have not to forget the university of the Zitouna in Tunis, the oldest of the Muslim Arab World. It was Obeidulah Ibn Al Habhab who built the big mosque of Zitouna in the year 732 which included later the establishment Zitouna for high education studies from one hand and also served as a hall for students.

It took over a century after the creation of these great knowledge centres in the Arab World to establish the first universities in Europe. The Bologna, Montpellier and Paris, which are the oldest in Europe, were set up only from the twelfth century, shaped similarly to their Islamic equivalents. This history tutorial is to say that during this period, the Muslim Arab world had become the first major producer of science as has become the United States today. It became the precursor and also the initiator of the promotion of science as the European Union is trying to endorse now.

4-2- The golden age

Becoming a major progress leader with a universal culture of its time, the Arab world turned out to be a dream

destination for brains and a landing point for the track of science by researchers. Baghdad, Kairouan or Cordoba were "Silicon valley" of their time. Every now and then it happens that a Latin philosopher, persecuted in Paris of the twelfth century, takes the path of Zaragoza to seek protection near, what we may call nowadays, an international notoriety leader as Ibn Baja (Alias Avempace). It was also at this same time qu'Ibn al Haytham (aka Alhazen), one of the founding fathers of modern optics who professed the separation of the two spheres: the sacred from the profane. He knew how to differentiate between things.

4-3- What do we become?

4-3-1- UNESCO report: a grim look

We are very far today from that golden age of Arabic science. Unfortunately, the present looks a little grim. The UNESCO, in its annual report on the state of science in the world, was very serious and severe about the state of science in the Arab world. Written by Adnan BADRAN, president of the Arab Academy for Science, the report paints an austere view of the situation.

4-3-2-Academic world ranking of universities: far from the leaders

Based on well thought-out performance indicators of science and technology, the Arab states appear at the bottom of the table and rarely outperform the African states. The situation is the least better when we refer to "the Academic world ranking of universities (ARWU).

The same is true for the relationship to science at basic schools. The International Mathematics and Science Study (TEIMS) survey of the International Association for Evaluation of Educational Achievement is not also encouraging.

4-4- What have happened since the golden age

Like all investigations that lead to international comparisons, those of the TEIMS and ARWU do not pretend to translate all the veracity about the education systems and universities.

On the other hand and in terms of scientific output, Arab universities, at least some of them, are not sterile. Unfortunately, a number of their elites, who don't feel at ease in their home countries, took the road to exile sometimes by force rather than by choice. They are now welcomed in to numerous laboratories of the USA, Canada and England, where nearly a third of practicing doctors are of Arab origin. This hemorrhage affects some countries more than others: the Maghreb Algeria, Palestine, Iraq, Egypt and Syria in the Near East. So, comes a question on everyone's lips: what have happened to the Arab world to become so cut out on the scientific front?

It is certainly not because of lack of money, since some of these countries, with their oil revenues are among the richest in the world and comprise universities that can compete with many universities in Europe or North America. In addition, we can not fully adhere to the statement of the president of the Sciences Arab Academy where he claimed "without freedom of expression, there can be no scientific culture and oppressive regimes obstruct creativity of scientists in Islamic states". Should we remind that the correlation between scientific development and level of civil liberties is hardly evident?

- Historically, Islamic science did not flourish in the past due to a recognized political democracy. Neither did the western science. It was created within a troubled political intolerance. This is to say there is no a principle antinomy between science and oppression.
- This collision well expressed in the perverted relationship between science and totalitarianism of the last century, Nazism in particular.

4-5- A question which needs answers: Ahmed Zoueil point of view

When questioned about this, Ahmed Zoueil, the only Nobel Prize in science of Arab origin said that "the sleep of science in the Islamic world today, which swathes all the Arab countries, is not the result of any inhibitions due to religion speculation of the mind. The past would be enough to prove the contrary. The cause is within the growing influence over time of obscurantist trends, in principle hostile to any scientific quests and any knowledge of all kind".

Mahathir Mohamed, former Prime Minister of Malaysia, the opponent of the Islamic curse gives few words similar to the interpretation of Ahmed Zoueil.

He asserts that "the real obstacle to the revival science is not Islam as such, but those enthusiasts of concordism, who reduce all knowledge to that of Koran. In sum, fundamentalism shuts any prospect for the future. "

This is a major problematic issue for "Arab" science centres, but also for other science centres who do not bother to see the growth of the mythical thinking which threaten the societies they pretend to serve.

5- Then, what about the approach of Arab science centres towards the mythical thinking rise?

5-1- Status of the Art

To try to answer this, we have to review the various existing, or planned, Arab science centres programs. All Arab countries develop scientific activities. These activities are carried out in universities and research centres. Some countries have even science academies. These activities relate to teaching and research. In addition, today there are commendable efforts that are being undertaken in respect to the popularization of science.

The activities related to the popularization of science have evolved through various media and institutions. Several Arab TV channels (e.g. Al Jazeera, children channel) emit scientific program, even if it is sometimes only technology programs not dealing with educative science as such.

Furthermore, the Arab newspapers talk abut the subject, today there is even an association of Arab Science Journalists, which has just been created.

Almost all Arab countries have scholarly associations, including astronomy. Some clubs are already quite old and have acquired their own traditions as Amman science and technology clubs established in 1972 with Jordan, mobile life, and science museum came to complete in 1988. Another example is the young science association founded in Tunis in 1974 and now having regional associations in almost all Tunisian cities.

What missing the most are the institutions of popularization of science like "science centres" or "science cities". In recent years, many centres have opened. This includes in particular: *Sharjah science museum, Discovery centre Sharjah, The scientific centre of Kuwait, Qatar science centre, Ryadh science oasis, Exploratorium- Bibliotheca Alexandrina, Gift student centre in Bahrain, Palais des Sciences in Monastir (Tunisia).*

5-2- An original experience in the Arab World where profane is separated from the sacred

To my knowledge, and I hope I am wrong, only the Sciences City of Tunis has made of this issue a major concern. It is the only Arab world institution of scientific culture that makes the difference between the profane and the sacred, where there is no concordism. Obviously, this that does not mean, of course, that when it comes to the question of origin of life, religion comes to interfere in the debate.

Indeed, the aim of Tunis Science City is to join in the dissemination of scientific culture to the various categories of citizens, particularly young people, throughout Tunisia.

The city must in particular:

- help in the context of dovetailing with the education al sector, promote and disseminate knowledge to provide all Tunisians with the benefits of progress and science.
- make the public aware of and familiar with scientific methods and discoveries by every sort of event, particularly exhibitions, demonstrations and every kind of documentation.
- awaken the citizens intellectual curiosity and make sure that, working together with the schools, youngsters from their earliest years are interested in science.
- point out the link between Tunisia's history, its present and its future n the field of knowledge and know-how, to create a context of science/society dialogue.

In Tunis Science City, science is here presented not by discipline, as often the case at school, but via a thematic approach which allows visitors to understand natural phenomena in their comprehensive nature. The permanent exhibitions are based on the idea of a scientific sequence to show that the laws governing our near and remote surroundings are universal ones.

As well as the Children's Park, the permanent exhibitions are housed in three big wings:

- ✓ First, the wing devoted to the universe and to the place the earth holds in the solar system, where the unit of measurement is the light-year,
- ✓ Then, the wing devoted to the history of life and of man, where time is counted in millions of years.
- ✓ Thirdly, after a geological time-scale period, we move to the place of human history in the wing devoted to the contributions made by Tunisians of every era to the enrichment of universal knowledge; Water has been chosen as the theme to illustrate and site this contribution. This sequence, where phenomena happen in different time-scales, will certainly help visitors to get a better grasp of relativism and thus develop a scientific spirit.

5-2- What about the other Arab World countries experience?

For the other science centres, we can divide the Arab region into two areas: the Maghreb and the Middle East.

In the Maghreb:

- ✓ The choice is quickly made; there is the City of Sciences of Tunis, one of the most important projects in the Mediterranean with a new science centre which has just opened in Monastir: the Palace of sciences.
- ✓ In Morocco, there is the museum of Mines and Geology, part of the Ministry which holds the same name. Then, there is the project of the City of Sciences of Tangier, which is currently developed with the support of UNESCO.
- ✓ In Mauritania, Algeria, Libya, there are no centers for scientific culture, or at least recognized as such.

In the Middle East:

There is a centre in Egypt and a lesser important one in Palestine. However, it is in the Gulf that most important centres are located.

- ✓ Several centres exist in Saudi Arabia, in Emirates, Qatar, Bahrain, where in addition to the Science Centre, another project is being prepared.
- ✓ However, it is in Kuwait where there is proper centre and which takes its weight from its size and also its contents. This choice is to the credit of the Kuwait Science Foundation, which is one of the few Arab institutions that undertook a real propaganda of science including the Arabic Scienctific translation and dissemination of books and journals.

However, one problem is still hanging about as all these centres, big or small, apart from that of Kuwait, are all designed as if science is only meant for children.

6- What should we do?

Unfortunately, in a world increasingly shaped by techno-science, and even in the most industrialized countries, there is no sufficient number of scientifically literate adults.

Scientific illiteracy in any country becomes a major handicap for both the economy as a whole and the individual citizen.

In addition, we are witnessing in the Arab world as elsewhere in the world, the rise of irrational beliefs and the development of pseudoscience as astrology or parapsychology.

The amalgam does not spare student populations where a large number is tempted by creationism deal against the theory of evolution or deliberately confuse the profane and the sacred. The sacred books, the Bible and the Koran become real books of science.

The pinnacle of this paradox is that we are seeing in some campuses of the Arab countries, students in science and technology trusting and propagating the mythical thinking whereas narrowing the critical thinking.

Probably, the problem is exasperated due to the fact that pseudoscience is not being discussed in schools. Also, the problem is worsening because, most likely, science, once admired and glorified, is now powerless to calm fears and to silence the woes.

A deaf and disseminated fear is then taking place whenever a scientific or technical innovation is proposed. We quickly draw a list of potential dangers that could be induced through this innovation, even though those risks were very low. This leads to young people, being frustrated, will focus their resentment on the most visible aspect of contemporary society, namely science and technology.

The phenomenon is particularly striking in many Arab countries. Yet historically, it is in these countries that culture has experienced for the first time a major scientific dimension.

Rekindling with this culture and reintroducing critical thinking, put science back into its right place. It will help to see the world as it is and not as we would like it to be, ultimately, that is what ought to be the primary mission of the Arab countries.The target must be less the dissemination of knowledge but to expand the ability of visitors to discuss advances in science. Indeed, and contrary to what proclaimed Jean Marc Levy-Leblond that scientific culture lies in the explicit answers to specific questions such as the distance between Earth and Moon, the speed of light or the size of the AIDS virus, instead, it lies in the ability to control operating statements.

It is less important to know than to know how to know: what to ask, where to look, what to read, who to ask, and why make the effort.

In other words, the popularization of science should become a debate on this privileged link, a forum for interaction between science and society, a space that introduces to the critical spirit and the sense of proportion.

7- Conclusion

Iwould like to conclude this presentation by some appreciations, strictly personal taken from my experience as a chief operator of the Sciences City, chairman, field animator, consultant in international science projects and

also a university professor who continuously remained in contact with his students.

1 Now We need, more than ever, science centres. We need great centres of the size of the city of La Villette, science city of Calcutta, Madinat al ouloum, the exploratorium in San Francisco. These institutions are often criticized because they are "budget-eaters", but we must not forget that they are institutions which lead us to the top and this is extremely important nationally and internationally.

   We need as well a science of proximity: a planetarium conveyed by a small car or a bus that we can display on the market place to convey a science close and accessible to all.

2- But whatever is our effort, we will only hit a small fraction of the population. On a European population of 600 million people only an average of 60 million people every year visit the science centres, in other words 10 to 12% of the total population.

I do not think we could do better in the Arab world, at least in the medium term. In announcing the participation rate, it is no point to question the contribution of science centres in the popularization of science but to say that their role remains marginal as long as they are not coupled with the educational system and university.

Not all the Arab countries have centres or cities of science, but they do all have universities, schools and colleges that hold nearly a quarter of the total of the population.

So can this forum in Seoul not only go towards strengthening the links between centres of same vocation but also between popularization of science centres and academic institutions, and even better schools, primary of them or secondary.

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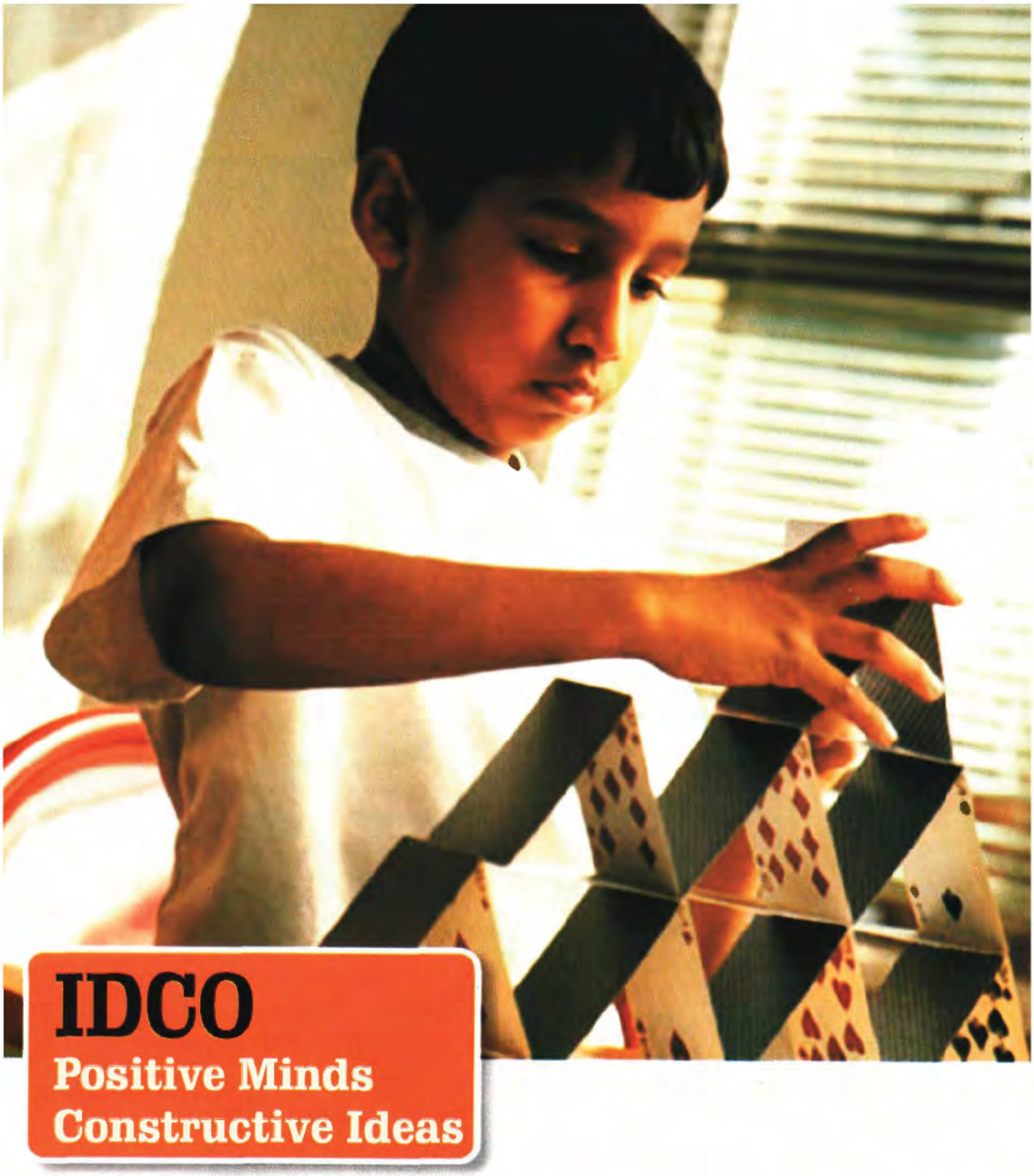


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Public Understanding of Science and the Scientist Understanding of People

Ennio Candotti
(Museu da Amazonia, State University of Amazon UEA)

To celebrate the 60th anniversary of Kalinga Prize, I would try to imagine what will happen with popularization of science in the next sixty years. Let us think about this theme together.

It is a usual remark that in the last century, science had been seen by people in a contradictory way: sometimes with hope, others with wonder, but usually with fear[1]. Why? Let us try to understand what is going on.

1. The scientist understanding of people's knowledge.

First of all, it seems to me that there is a lack of understanding from both sides: from the public yes, but also from scientists. Public understanding of science, I suppose, means also that science should understand people, what they believe, their ways of thinking etc. They are not an empty box to be filled by scientific concepts and explanations[2].

i. Usually, we - scientists and scientific communicators - are engaged in popularizing the achievements of science. We try to communicate with images and metaphors our wonder and enthusiasm about them. Sometimes, but only sometimes, we explain also fundamental concepts, methods of inquiry and the limits of value and extent of our explanations. We suppose that is a commitment of school education. But frequently the school doesn't explore, with the necessary experimental support, such themes[3].

ii. Seldom we ask our listener, or reader, if he has understood what we are talking about, and more how he explains the same phenomena we are talking about, or which ethical values he attributes to our achievements or the way we evaluate risks in practical applications.

iii. Or even seldom we ask if the words we use, like energy,force, interaction, cells or genetic code, have similar meaning in their language and imagination to ours.

iv. The main role of Science Centers and Museums and Science Popularization efforts is, alongside the school, ultimately, to unify the two (or more than two) conceptual worlds, the layman and the learned one: through models, examples, images, metaphors and practical experiences.

2.Science popularization, cultural differences and social sciences

To illustrate the differences, and trying to find the paths to the bridge, I will tell you a real story, in which I try to compare the explanations in different cultures of the same natural phenomena.

i. *The Ticunas myth of moon's birth.*

Once in a Ticuna community, during a physics teaching program to (Amazonian) indian school teachers, in far west Amazon, we were discussing the reasons why the moon doesn't fall on the Earth, like a stone.

I asked if they could tell me which were the reasons, in their own culture, to explain the fact that the moon doesn't fall on Earth.

So they told me:

"Once in a village, every night a young girl was visited by a young man who, before dawn, still in the dark, silently, left her.

Intrigued with the fact that she didn't know who the young visitor was, one night she stained her hands with the black juice from a fruit and, when the young man hugged her, she pressed her hands on his shoulders leaving a mark. Later that same day she recognized the young man. He was her brother.

[1] *Science and Technology, Third Report, House of Lords, 2000, UK*

[2] *Idem, chapter 3.*

[3] *Rarely do we emphasize the limits and particular conditions of value of our statements. For instance: all objects fall with the same acceleration, yes all of them, but if and only if there is no air in its way. And air exists, and we are immersed in it.*

She told the story to the elders of the village which decided to expel the boy, sending him to the sky where he became the moon.

Others told a different conclusion: The young man was so ashamed that he refuged himself in the sky where he became the moon."

ii. To substitute the interactive 'o ces and movement's constraints of our physical explanation the Ticunas use ethical principles – in this case the forbidding of incestuous relations – a social norm that regulates the parental relations of community. In both cases the purpose - of physics or of the myth - is to preserve the bounded state of the two bodies, keeping the coupling, but at certain distance between them, avoiding physical contact. Ticunas doesn't care with the fall. They believe that the Moon has no reasons to fall on our head. Physics in skys and Earth are not the same.

iii. I have told this little story because I would like to emphasize the need for the help of the social sciences, in this case of anthropology, to our efforts of to popularize science and scientific culture[4].

iv. They could help us to put a "grano salis", just a "little bit of wisdom", in the effort to popularize science and its formidable achievements of the last century. To have a special care when we treat the gods of progress and the economy's markets myths.

3.Interdisciplinary trends in science and in science popularization

Modern science found the keys of its extraordinary success in the moment it discovered the importance of the observation of the natural phenomena from a particular point of view, in which they appear with its maximal simplicity. But the specialized and disciplinary paradigm has severe limits particularly in biology and in social sciences where the description of one particular observation seldom gives sharp hints for the understanding of the whole phenomena.

New interdisciplinary paths have been developed in studies of questions of social and natural sciences. Beautiful examples can be found for instance in studies of psychoanalysis and neurophysiology one trying to understand how the brain works from the 'inside', the other from the 'outside'[5].

Science popularization of ecological questions also demand creative interdisciplinary treatment. Particularly when we try to explain to people the fragile ecological equilibria or the behavior of animals and plants in their natural habitat or the secrets of social insects.

The new generation of zoo-botanical centers, aquariums and natural history museums try to connect animals, plants and fishes to their natural habitat. In their original lands, waters and climate: in Africa, India or in Amazon rain forest or river.

That is in my opinion a new important challenge for popularization of science. Show and explain the interactions between plants and insects, microorganisms and trees in real time and in the natural place where they happens.

The optical and acoustical instruments of the real time observation are at our disposal. And today they are much cheaper than ten years ago. So it is possible, technically and economically, to create 'theatres' where the play of life can be performed and observed, in original habitats of the 'actors'.

Soon - sooner than sixty years, I believe – in the new 'original habitat museums', it will be possible to show (with or without instruments) to people - and wonder children – living leaves, insects without pins, flying birds and walking mammals.

4. Science popularization and the international political crisis of our days

If we want to foresee the next sixty years of science and politics in the world, we need once again the help of social sciences, particularly in the effort to understand the present world, plunged as we know, in a deep economic and political crisis.

i. It is not difficult also to characterize the main trends that will prevail in the world in the next decades: China, India and Brazil will increase its economic and political presence. I saw recently a German scenario in which before 2050 China will be the major economy, followed by the USA, India and Brazil.

ii. India and China have a large population (billions of people) which in the next decades will be increasingly incorporated in the universe of consumer society, science education, health care, housing etc.

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[4] *Claude Levi Straus, La Pensée Sauvage, Plon, Paris 1962*

[5] *F. Graeff, Ciencia Hoje, 287, sup. sobreCultura, November 2011.*

The same holds for Brazil, even if in a lower scale. Thirty million people have been rescued from deep poverty in the last ten years. We have thirty millions more to rescue. You, in India, are dealing with numbers ten times bigger.

iii. If we consider other countries in which similar revolution is going on, we are speaking of more than two or three billions of people who are fighting for dignity, food and citizenship in the planet. Science and technology production, its answers and demands, will be deeply disturbed by the new political and cultural trends and pressures[6].

New social and economical values and priorities should emerge and probably prevail. Cultural demands from different origins will challenges science and will require, to our local and international community, the imperative commitment with new ethical choices.

iv. By the way, I agree with people that don't believe that science policy in Europe, Japan and USA will be the same anymore after the 2008 economical crisis and the national markets will increase its economic importance particularly in China, India, Brazil etc[7,8].

v. So I hope that social and economy sciences, once again, will help us to understand world politics and the new social concerns and commitments to techno - sciences. And reflect with us about the public understanding of science and also discuss with us how to define new paths for science policy and find ways to democratize knowledge. To find paths which respect and preserve de cultural differences.

5. "To Live together" a motto for the next sixty year science popularization

If the mentioned scenarios will prevail, which examples could illustrate the challenges in sciences and science popularization in the next twenty years? Let us consider a few concrete Amazonian examples, the land where I live in.

i. At the riversides of the immense Amazon river there are many thousand little villages, each one with no more than 100 people living there, distant one or two days by boat from each other. Far away from centers equipped with public services of health, education etc. These people live in poverty. But from fishing, bananas, some corn and manioc agriculture, worked with ancient - and sometimes surprisingly efficient - technical culture they get how to survive.

ii. By the way, it is worthwhile to mention that the water level of the immense rivers oscillates 12 to 15 meters amplitude during the year. Drowning more than 500 000 km^2 of forests and meadows. The numbers of Amazon's bio, socio and geo diversity are always immense.

iii. Amazonia was in the past (a thousand years ago) densely populated and its inhabitants developed, since old times, clever techniques of survival in wetlands. They learned agriculture techniques, housing, fish handling, boat carving and provided health care through a large use of plant extracts and natural products.

iv. But, to get good drinkable water is still today a huge problem. Such as other tropical neglected diseases like for instance malaria. The architecture of houses in periodically flooded areas is not object of studies and improvements, neither transport or communication systems. Health and sanitary care, education and how to get some regular income are challenges not yet well solved.

v. Nevertheless it is absolutely necessary to keep in the Amazon many thousands of well equipped forest families technically prepared to care for waters and forests, to monitor the bio, geo and physical environment and to prevent fire and predatory fishing in lakes and rivers. They are indispensable. To take care of the environment it is necessary to have trained and equipped people permanently living there.

vi. On the other hand, the burning of Amazonian forests, its climatic impacts and its conservation is largely discussed in international environment conferences. If we would really take care of that region, and its ecological equilibria, it is not sufficient to search answers in international commitments and carbon's stock markets credits. We need - and this is

[6] *R.Dagnino, Politics of Science and Technology, V CTS, Buenos Aires, AAAs, November 2011*
[7] *Colin Macilwain, Nature 479, p.447, 24 November 2011.*
[8] *Budapest conclusions of the 5º World's Science Forum, November 2011*

urgent - a scientific collaborative effort to better know what happens in waters and forests. To know better, much better, the social, archeological, climatic, micro bio and macro bio Amazon's world.

vii. In short words: our major challenge in the Amazon is to demonstrate to economy agents that one km^2 of forest has a monetary value higher than timber, few sacks of soya bean or the few cattle heads raised or cultivated in place of the wasted forest. The answer to that question has today a huge ecological, social and economical value.

viii. It is a real defeat, and reason of deep frustration, not only for biological sciences and particularly to microbiologists, but also for the science popularization movement, that the forest is still today evaluated in tons of CO_2 stock! And not by common people, but by learned executives of international conferences! Give me a break!

6. Brazil's science and popularization movement

In Brazil the movement of science popularization is very young, has the age of Kalinga Prize, six decades not more. "Ciencia Hoje" the Science Today a pioneer monthly review in whose creation I participated and, I suppose, is the main reason of my presence here, is only 28 years old, and its daughter, Science Today for Children is 25. But the number of Museums, Science Centers and Botanical Gardens, is growing faster in Brazil during the last decade, particularly in the last years.

i. Well, millions of people participate in the last seven years at annual science weeks, or mathematics, physics and astronomy Olympic games.....But we are still 10 years distant from Indian scores, where the science popularization movement is older and better institutionalized.

ii. Between them the Museum of Amazon, the Musa, the project in which I'm working, is a live museum in the rainforest[9], a museum of anthropology and biodiversity. Our headquarters are in a original and well known strip of an 100 km^2 huge rainforest laboratory the Amazon Institute of Research (INPA) in the neighborhood of Manaus city.

iii. The cultural, educational and social sciences commitment of Musa are strong. Living in the Amazon are not only the mentioned riverside communities but also more than 100 different ancient ethnical groups, many of them still conserving their traditional culture and speaking their own languages. An invaluable cultural heritage and rich traditional knowledge's source.

iv. Our aim? Inform and educate people to respect differences, so in biology and ecology, as in anthropology and in culture. With the help of social scientists we try also to understand – learn with and teach - people, of Amazonian Indians and non Indians, traditional and riverside communities. How their social relations work? And their interaction with nature, forest, animals and waters?

v. In Amazon eighty per cent of the population lives in cities and it is not self evident that people respect the forest, waters or Indian cultures. Usually they do not understand them and even less tolerate differences. Nor in schools, forests and cultures, are object of special science classes or literary curiosity.

vi. So Musa is an institution dedicated to promote environmental scientific and cultural education in a key region for the World planet's ecological equilibrium.

ix. The 'living museum of Amazon' is the project of theatre already mentioned. An interactive science and culture center in the rainforest. We would explore interactions of forest's players between them and with water, soil and climate. We try to show to visitors insects, birds, frogs, flowers, butterflies, with instruments if necessary, always alive, in real time.

It is an institution devoted to knowledge and environmental conservation, dedicated to defense of human rights, to popularize science and education, and overall to promote tolerance and respect of what and who is different in nature, culture and human behavior.

An institution committed to science, and better understanding of people, and to enjoy our common wonder before nature's diversity in our planet. To promote the motto "live together" under the same sky, in the same earth, of human and not human beings.

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[9] *WWW.museudaamazonia.org.br*

Popularization of Science Among Marginalized Young Persons - A Ruchika's Initiative

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During the last century, a lot of remarkable developments in the field of science and technology have taken place and brought about many changes in our life style. Man has been able to conquer time and distance. The green revolution has done away with hunger. Knowledge and skill can empower man to get over human misery and deprivation prevailing in the modern world. The world has become a global village due to the ongoing information revolution. The global revolution has placed in our hands the power to alter the blueprints of life. Similarly, there has been spectacular progress in the perfection of weapons of mass destruction and a massive competition on innovative and powerful weapons among the nations glows our eyes.

Of course Science has contributed a great deal to the human welfare. Through the gospel of reason and experimental observation, by which it works, it has enabled man to acquire intellectual and mental excellence. From the materialistic point of view, ranging from environmental issues, disease eradication, space exploration, energy production, information highway to name a few, science and technology has broken barriers to bring peace and prosperity with a cleaner environment with sustainable use of resource for the benefit of mankind. Biotechnology is making a major impact on agriculture, health, environment, industry and pharmaceuticals. Communication at lower costs, with greater accessibility, is another product of technology.

At the same time the state of children in our society especially those live on the streets and in the slums and those spent their lives on the railway stations is very discouraging and a large section of them are undernourished, go without shelter, are not properly treated in their illness and grow even without many of their basic needs having been met. There are still children who are deserted and rendered orphan with no one to take care of them. Children are forced to work in a pitiable state for their very sustenance. They are often victims of fortune and maltreatment. Many children are the unfortunate victims of family abuse and willful violence committed by the adult society. The instances of children used for prostitution are also galore. They are still sexually exploited. Thousands of children die or get maimed during wars, natural and man made disasters. Innumerable children die daily of starvation, undernourishment and neglect. The children on the street and of the street are totally ostracized from society. Denied security and the joys of childhood, education is a remote dream. The street is their heritage-drugs, crime and flesh trade their way of life. Those are the unfortunate children and often the society ignores them while planning for any scientific research or any innovation in the field of science and technology.

Thanks for green revolution which developed new types of crops and dramatically improved grain production, a world without hunger is now within our reach. It was only possible due to rapid advancement of science and technology in the field of agriculture. But a hunger free India will then be possible if adequate attention is given to the marginalized sections. This can be done by promoting a job-led economic growth plans and ensuring that the marginalized ones have access to safe drinking water, basic health and hygiene facilities, primary education and all that is necessary to live a qualitative life. The nation which considers its children as the greatest assets of the mankind and priorities them during all kinds of plan can only progress towards an egalitarian society.

Nature has endowed us with the instinct to love and take care of our children. But the fast-growing complex life style which has taken its shape due to advancement of science and technology often makes our natural commitment towards children unfulfilled. We are more often than not oblivious of our grave responsibility to our children.

Ruchika Social Service Organisation, a leading NGO of the state of Odisha, believes that the most basic education instills a sense of confidence, purpose and insight that is necessary for successful and productive participation in any society. Without at least scientific literacy, children and adults lack the ability to adequately support themselves in a legitimate profession or trade and thus often fall prey to all forms of exploitation, corruption and abuse.

The organisation helps inculcate scientific temper among school children especially those live on the street and in the slums. Health and hygiene issues are prime concerns for

these underprivileged children. The daily application of science like the use of clean drinking water, knowledge to eradicate contagious disease, cleaning of hands, taking cheaply available nutritious food, the know how of various agricultural practices to increase crop production including organic farming etc. are disseminated to the future generation.

The organization promotes interest of students in the subject of science and develops a scientific attitude and outlook among them. It helps extend immensely the limits of their curiosity. They are taught how science has been of the greatest help and benefit us in a variety of ways. It is difficult to say how much we owe to science in the affairs of our daily life. From morning to midnight, we are served tirelessly by science and scientific devices. It creates awareness about the role of Science and Technology as a major instrument for achieving goals of self-reliance and socio-economic development.

It gives a knowledge base and highlights the applications of scientific concepts and technological advancements in the fields of agriculture, energy, industry, health, natural resources, transport, communication, computers, Bio-technology and many other emerging fields. It also provides opportunity to students to give shape to their creative ideas and innovations through science exhibitions. The marginalized children do have potential in the field of Science and Technology and this blossoms if opportunities are given to them.

Biju Babu - As I know

Sri Bimal Das
Secretary- cum-Treasurer,
Kalinga Foundation Trust, Bhubaneswar &
Convener, Reception Committee

During my young days in college in 1962, I came across this extraordinary strange personality Biju Babu on the Cuttack Road after he won the assembly election with thumping majority for the Congress Party in Orissa. He walked all the way from Cuttack Collectorate office to the Cuttack Railway Station which is about 4 KM and we ran along with him. That was the first inspiration I got from Biju Babu and I changed my name to the present smaller version from a very long one. From that day onwards, I was his admirer and I tried to copy his ways of functioning as far as possible in my life.

Years rolled on. Although, I was a leader of the College Union, due to some personal obligations, I joined Govt. service not politics. I would like to mention that I came from a political family and my father was imprisoned in a British Jail and he was personally known to Biju Babu.

In subsequent days, my wife joined politics and after Jay Prakash Movement, she joined the Janata Party under the leadership of Biju Babu and got some high profile posting in the party. After that again, my relationship with Biju Babu increased manifold and my children became very close to him & we became his family friend.About his heroic activities, I would like to mention one or two incidences before I close. After I joined Kalinga Foundation Trust, which was the brain child of Biju Babu as the first Managing Trustee ,I had to visit many times to UNESCO office at New Delhi for the Kalinga Prize work. In one such occasion, during 1996, I met an old Cuban gentleman in the Director's room who was the Asst Director General, UNESCO, Paris during 1952. He came to know that we are discussing about Kalinga Prize, then he narrated an incident which I feel should be told to the people of Orissa. He said – " In one morning hours in my office at UNESCO, Paris, a tall man in white suite & red tie entered in to my room and threw away a piece of paper and 1000 pound currency notes and said , here is the fund, here is the approval of Director General and you start giving Kalinga Prize and left my room immediately. I ran after him and could not catch him as he was very fast. I went to my Director General and asked who is this man ? He told me that he is Biju Patnaik from India and is very dynamic and you start to work out to give the Kalinga Prize from this year." This incident confirmed by the then 5 young oriya scientists who were deputed by Biju Babu to read the technique of extracting petrol from coal , as Biju Babu gave a dinner to them in Paris in the evening.

One peculiar thing I have seen in him that always his head is held high. I think, he perhaps followed Rabindranath Tagore's poem for this throughout his life. One such incident is that once in New Delhi Odisha Bhawan perhaps in 1994, he was camping when I used to stay with my wife Meera Das in Odisha Bhawan. Once there was a News Paper flash that Chief Minister of Orissa Sri Biju Patnaik is tipped as the next Vice-President of India. I was thrilled after seeing the news item and ran to his room which was open to every body at all time. I showed him the News Paper and my comment was that one day he may be President of India. But he suddenly got angry with me. He said you should know who is what. He enquired from me who is President of India? I said Sri R. Venkatraman is President. He commented that Mr. Venkatraman was a Dy Minister with Mr. Kamraj in Tamilnadu when I was Chief Minister of Orissa. How do you think that I will be Vice-President of India and work under him? Finally he did not perhaps accept the offer.

These are few incidences I am quoting. There are no. of his dynamic & heroic activities which should be noted in the history of Orissa.It would not be possible to give every thing here. He was a great heroic & dynamic

leader and what not? His foot prints are everywhere including Rourkela Steel Plant, Regional College of Engineering, regional College of Education ,Paradeep Port, Hindustan Aeronautics and finally NALCO in Damanjodi and Angul with head quarters at Bhubaneswar.

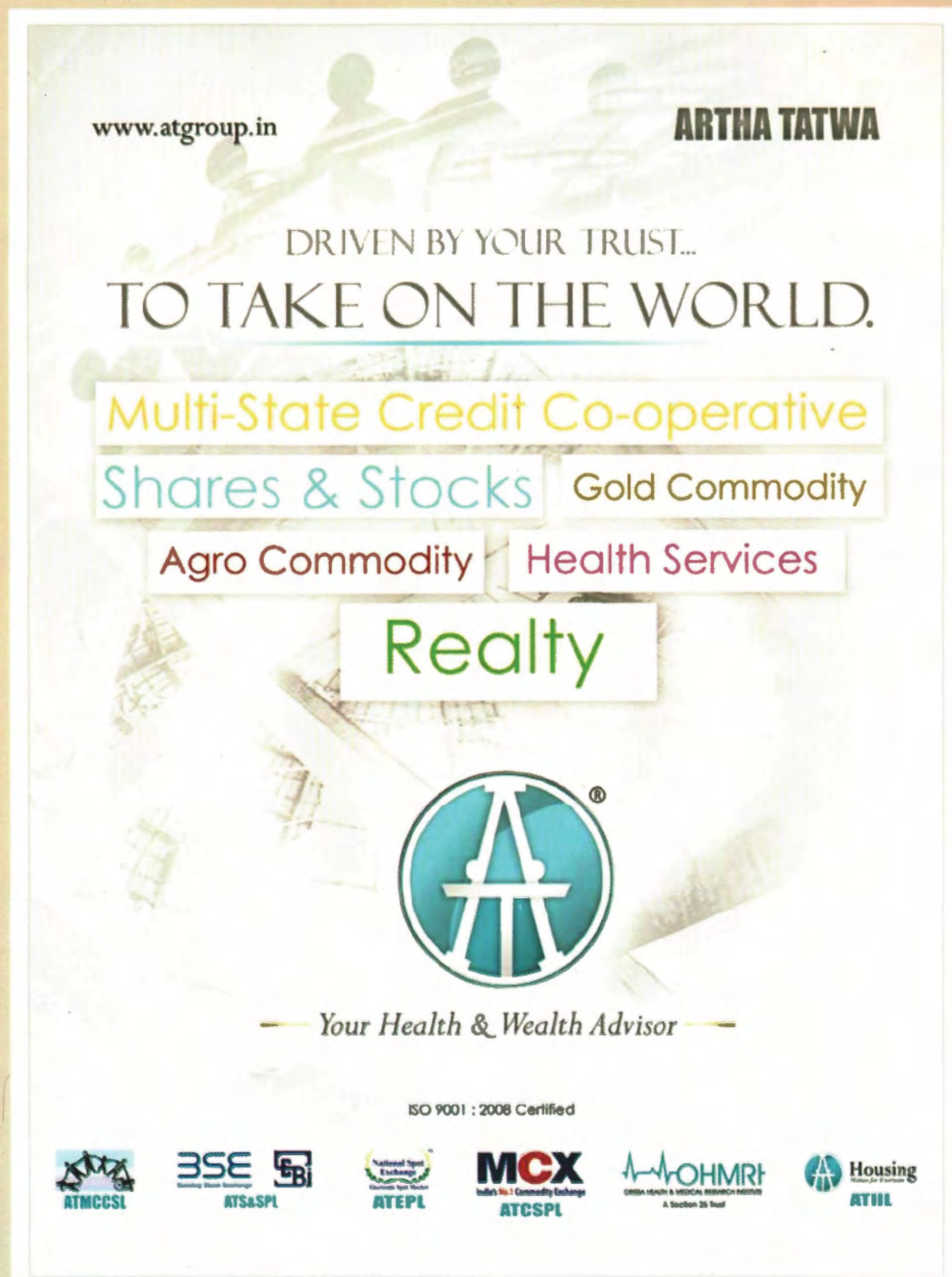
With this, I salute Biju Babu, my hero, Orissa's hero with tears in my eyes. It is unfortunate that he could not see this glorious function jointly organized by his brain child Kalinga Foundation Trust and UNESCO, Paris; DST, Govt. of India, Ministry of HRD, Govt. of India and Govt. of Odisha for celebration of 60th anniversary of UNESCO Kalinga Prize being held at Bhubaneswar during 4th to 5th January, 2012.

I still quote his voices "In my dream of 21st century for the state of Orissa, I would have young men & women who put the interest of state before them. They will have pride in themselves, confidence in themselves. They will not be at any body's mercy, except their ownselves. By their brain, intelligence and capacity, they will recapture the history of Kalinga".

It is my earnest desire at last , that let every body of Odisha try to follow this.

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